Asia Pacific Journal of Management and Education (APJME)
Vol. 4 No. 3, 22-34, November, 2021
E-ISSN: 2655-2035/P-ISSN: 2685-8835
DOI: https://doi.org/10.32535/apjme.v4i3.1263
https://ejournal.aibpm.org/index.php/APJME

Development of Web-Based Digital System Learning Media

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ABSTRACT

In classroom learning, students frequently face challenges to understand the material since the learning media deviates from the subject content. The media usage as an intermediary for delivering information makes it more varied, easy to understand, and interactive. Utilizing web-based learning media promises the independence of time and place and helps the learning process. This study aims to develop a web-based digital system learning media that is feasible and useful. The study uses the waterfall model software development method, namely the Multimedia Development Life Cycle (MDLC). The findings indicate that the web-based digital system learning media is feasible and useful in the learning process.

Keywords*:* Learning Media, Multimedia Development Life Cycle, Web

INTRODUCTION

Learning in the classroom and outside the classroom by utilizing information and communication technologies helps both teachers and students. According to Maza, Lozano, Alarcón, Zuluaga, and Fadul (2016), the application of newer and flexible learning technologies is beneficial to encourage students to achieve more professional skills.

Due to the high flexibility and portability enabling the device to support communication and information, it is now easier to use virtually, for example in online learning (e-learning), anytime and anywhere. The easier it is to access learning materials, the more it triggers the enthusiasm and interest of students (Yuniati, 2011). Measuring the interest among students in e-learning is significant for its sustainability (Khafit, Sulastri, & Fauzan, 2020). The learning media can stimulate the affective domain of students to be successful in their learning activities. The affective domain consists of attitude, interest, confidence, responsibility, and honesty (Ponto, 2020).

The online and offline learning in PTIK Department of UNIMA is experimental because Internet access is not available, and the available instructional media is limited to media presentations and interactive. The content of the material is not the same as the course syllabi. Further, the web-based media content does not provide the same material.

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The utilization of instructional media as an intermediary for the information delivery makes the media should be more varied, easy to understand, and interactive. Learning development by utilizing web-based media promises independence of time and place facilitating the learning process.

In building a learning media, the pedagogic aspect becomes is vital. It requires an appropriate strategy (Silveira Sonego, Rocha Machado, Wildt Torrezzan, & Behar, 2016), and becomes a benchmark of learning media development. However, teachers find it challenging to implement learning strategies into the various available learning media. This happens because they have limited ability to build digital learning media. As this occurs in many schools in Indonesia, a solution should be provided.

Several solutions have been suggested, such as providing training teachers to build digital media. Nevertheless, not all teachers can build digital learning media because of several factors such as low information technology readiness, limited information technology infrastructure, and student readiness to accept learning by the digital media. In fact, it is essential to provide digital learning media connecting students in learning (Hanum, 2014), and widely utilizable.

Providing a website-based learning media, which is accessible via the internet, is a good choice. It allows gives students and teachers a big advantage not to install certain applications, yet simply provide a browser application to access learning media websites. Various devices, such as personal computers, laptops, mobile phones, and tablets, can be used.

The purpose of this research is to build a website-based digital learning media, which is expected to continuously be used by teachers and students in learning activities, either face-to-face or virtual learning. In addition, it is expected to produce a digital learning media product that is tested, has good quality, and suitable for widespread use.

RESEARCH METHOD

This paper applied a method of software development model Waterfall namely Multimedia Development Life Cycle(MDLC). The development model, according to Sutopo in Munir (2013), consists of six stages. They are conceptualization, design, material collection, assembly, testing, and distribution (see Figure 1).

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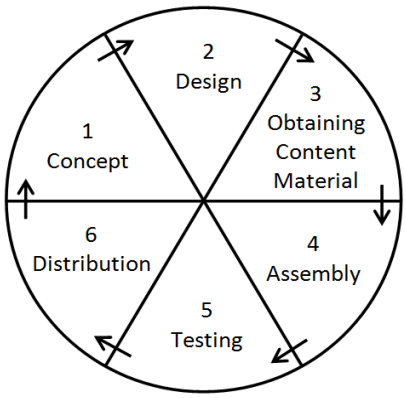
Figure 1. Multimedia Development Life Cycle



The conceptualization stage is to determine the program purpose and user (audience identification), the type of application (presentation, interactive, etc.), application objectives (information, entertainment, training, etc.), and general specifications. The rules for designing are also applied at this stage (application size, targets, etc.) in which the objectives and end-users of media development and characteristics of the user become an input. The steps of the drafting activity consist of:

a. Determining the purpose of the product making
b. Preliminary observations product users (students of UNIMA PTIK).
c. Initial interviews with a team of lecturers in the digital system course.

In the design stage, the process consists of making the program architecture specification, style, appearance, and material requirements. Specifications are made as complete as possible to avoid significant changes in the obtaining material and assembly stage. The activities will include the determination of the material and manufacture of product design.

The material and assembly stage includes collecting materials that are in accordance with the needs. The materials comprises clip art images, photos, videos, audio, or other materials as needed. The assembly stages and these stages can be done in parallel or non-parallel and linearly.

To build digital media products, we pay attention to the content of learning materials. The materials are produced by taking into account the existing curriculum and learning plans. The main goal is the material suitability with the learning media, similar to what has been planned by the teachers to get it continuously used in learning activities. All materials and evaluation plans are built according to proven research procedures (Arikunto, 2010).

The assembly stage consists of the following steps :

a. Preparing materials for the overall manufacture of products

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b. Combining parts of the material as in the obtaining content material stage
c. Creating a program according to the storyboard that has been made.

The existing materials are combined into one product. When another material is added, a revision is needed.

The testing stage is carried out after the manufacturing stage because it is conducted to determine an error. According to Pressman (2001), testing is a series of activities that can be planned in advance and carried out systemically. Software testing is a topic element that has a wide scope and is often associated with verification and validation (Rosa & Salahuddin, 2015).

The testing stage comprises unit testing, integration testing, system testing, and acceptance testing. Unit testing relates to the correctness of the functional and completeness of individual program units such as functions, procedures, or system components. It is performed by the developers themselves. The integration testing stage is a systematic technique for building software architectures, which is to find errors associated with the interface, which aims to take the components tested and build a program structure determined by the designers (Pressman, 2001). The integration testing is used to measure the functional, performance, and reliability of software which is done by using black-box testing techniques (Watkins & Mills, 2011).

At the testing stage, the integrated process units are tested with an interface that has been made so that the overall software system is tested as a system (Rosa & Salahuddin, 2015). Acceptance testing is used to determine customer or user satisfaction (Rosa & Salahuddin, 2015). It can be used to measure software usability by using black-box testing techniques (Watkins & Mills, 2011).

In addition to the testing phase, there are testing techniques that can be done to support this testing phase. They are Black box testing and White box testing. Black box testing or functional testing is testing on software-related functionality. The test is performed to determine whether the functions, input, and output of the software in accordance with the requirements specification (Rosa & Salahuddin, 2015). White box testing is a test based on a careful examination of procedural details (Pressman, 2001). Rosa argued that testing software in terms of design and program code, whether it is able to produce functions, input, and output in accordance with the requirements specifications is white box testing. In addition to previous tests, there is validation testing. It consists of two types, alpha testing and beta testing. Alpha testing is testing from the developer side by a group of representatives from end-users, and beta testing is carried out by one or more of the end-users (Pressman, 2001).

The distribution stage is the stage for storing applications that are developed onto storage media and can be duplicated and given to users for use. Distribution can take the form of presentations on projectors, CD-ROMs, mobile devices, and websites.

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RESULTS AND DISCUSSION

The development steps used are the Multimedia Development Life Cycle (MDLC) development model, consisting of conceptualization to distribution.

Concept

This stage is to determine the purpose and who the users of the program are (audience identification). At this stage, the initial planning is carried out to develop web-based learning media. The activities carried out are goal setting, initial product identification, and interview.

Goal Setting

Learning media will only be used in the Digital System course. This product will be developed from interactive multimedia-based learning media that was created by earlier authors and used in learning Digital Systems. The existing interactive multimedia-based learning media has never been used on a web-based basis. Upon further review, several keys did not work properly and the use of the Internet means that it is possible and wifi supported, then a web-based learning media is developed.

Initial Product Observations

The preliminary observations are conducted to determine the product. Students who contract the Digital Systems course after making initial observations note that this interactive multimedia-based media provides more fun. In addition, it is also known that several courses have used smartphones as a learning tool as long as lecturers can oversee the learning process in class. And all students have smartphones but not all students have laptops

Interview

The interviews were conducted with lecturers in Digital Systems courses, and 2nd-semester students joining Digital Systems courses. The interview results confirmed that students were allowed to bring smartphones, which can be used during the learning process while the lecturer can supervise them. The students were also very enthusiastic about learning using their smartphones or laptops.

The interviews with the lecturers were related to any difficulties experienced while teaching Digital Systems courses using learning media or not, material understandability, the reasons for, and the effects of it. Also, solutions for learning difficulties and student opinions regarding the use of interactive media were also investigated. Based on the results of interviews and surveys, the web-based learning media is suitable and useful in the learning process and it is used for Digital Systems courses.

Web-based Learning Media

At the design stage, specifications are made regarding the program architecture, style, appearance, material, and material requirements for the program. Specifications are made as detailed as possible so that at the next stage, namely obtaining content material

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and assembly, new decision-making is no longer needed. The activities include material specifications.

This includes determining the material to be included in the web-based learning media. The learning materials are course materials for the Digital System course of odd and even semesters. The material refers to the syllabus. It comprises the Number Systems, Logic Gate, Boolean Algebra, Combinational Logic Series, and Sequence Logic Circuits.

Product Design

Before the products are made in the assembly stage, it is necessary to make a preliminary design for ease of product manufacture. The process comprises program flow making, flowchart creating, storyboard creating. The flowchart describes the flow of learning media and aims to organize each page that will be made. The storyboards illustrate the overall picture of the product.

The program flow starts with the initial display of the Home page. The Home page will later select an exit button or a button for the material. When you press the material button, there will be a material display consisting of a choice of Material I, Material II, Material III, Material IV, and Material V. Meanwhile, if you choose the exit button, the program will come out with a choice question, namely Are you sure you will exit? If the Yes option is clicked, the program will exit, if the answer is No, the program will return to the Home section. When choosing Material I, Material I will be read and when finished reading Material I will be followed by an Evaluation for Material I. This also applies to the choice of Material II-V. The flowchart contains a "START" image, followed by reading data from "DIGITAL SYSTEM MATERIALS". After the process continues, the choice of MATERIAL I data displays (YES), then goes to Material 1 data, if NOT, it will go to the Exit option. If Material II is not selected, the data will display Material II, if NOT, it will go to the exit option. Even if the Material II option is not selected, Material III will be selected. Then, it will be forwarded to the Material III option, if not, it will directly go to the exit option. If the choice of material is Material IV then it will be forwarded to Material IV, if it is not selected, it will go to the exit option. Material V is the final choice if Material I-IV is not selected. Material Option V will display Material V data if the “YES” option is selected. It will go straight to the exit option if the choice is "NO". All options "NO" from the I-V Material selection will be given the option "SURE WILL EXIT?". If you are sure you will exit, you can select "YES" and if you are not sure to exit, you can select "NO". Choosing "YES" will end the process of reading the Home page. But the option "NO" will return the process of reading data back to "DIGITAL SYSTEM MATERIALS". Then the process of reading the Digital System Material will act as the flow earlier described.

Obtaining Concept Material

This stage is to collect the materials in making the Digital System learning media. The materials were collected from several sources and self-made for pictures, sounds, materials, and practice questions.

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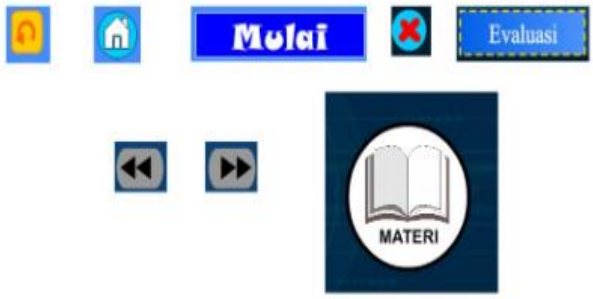
Figure 2. Materials



The images in Figure 2 are from Adobe Photoshop CS6 and Adobe FlashCS6 applications. While the votes used in this media are taken from https://youtu.be/h6_8SIZZmvQ

At the assembly stage, the overall media development is built and programming is carried out to create applications. This product is made with Adobe Flash CS6 software. In more detail, the stages are:

1. Preparing the text on the material for the entire product manufacture,
2. Text material for Digital System learning media is based on the syllabus of the Digital System course as it has been collected at the obtaining content material stage or the material collection stage,
3. Merging parts of the material collected at the obtaining content material stage,
4. Determining other materials in terms of appearance to attract attention,
5. Making a program in accordance with the storyboard guide that has been made previously. All parts of the material that have been collected are then combined into one product, which will then be revised,
6. Determination of the content of each page is carried out at this stage because each page has its own content tailored to the concept of the product.

The following is a description of the content for each page in detail.
Home Page. It is the initial display, which contains three buttons and the title of the product. The button at the top right is the "Exit" button to exit the application and the button in the middle is the "material" button to enter the content page.

On each page. On each page on the upper left, there is a button in the shape of a house, which if clicked will redirect to the main menu (Home). On the upper right side, there is a cross button (X), which if clicked will lead to the confirmation display to exit the application. On certain pages such as the content page of the material, there is a button in the form of an arrow to the left when clicked will lead to the previous page (Back button). The right arrow button will lead to the next page (Next button).

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Main Page. Main Page contains the main menus of each page. There are five main buttons on this page. The first button is the Material I button, which if clicked will redirect the user to the Material I page. The second button is the Material II button, which if clicked will redirect the user to the Material II page. The third button is the Material III button, which if clicked will redirect the user to the Material III page. The fourth button is the Material IV button, which if clicked will redirect the user to the Material IV page. The fifth button is the Material V button, which takes the user to the Material V page.

The Material. The Material page consists of Material I, II, III, IV, and V buttons and two buttons to exit, which lead to the Home page. The button on the left will redirect the user to the Home page. The button on the right takes the user out of the program and the I-V content button directs the user to the Digital System material (see Figure 3).

Figure 3. Initial View of Application

Testing

The testing stage is carried out after completing the assembly stage. It includes unit, system, and acceptance testings.
The unit testing is carried out using black-box testing techniques.

The results of unit testing can be calculated using the Percentage of Feasibility formula (%) as follows :

$$\text{Percentage of Feasibility (\%)} = \frac{\text{Score}}{\text{Score max}} \times 100\ \%$$
$$= 6/6 \times 100\ \%$$
$$= 100\ \%$$

The result of the calculation of the percentage of eligibility for unit testing is 100%. The quantitative values obtained are then converted into qualitative values based on the media rating scale. The unit test results obtained are the interpretation of "Very Appropriate"

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The acceptance testing is used to determine customer or user satisfaction with the software being developed (Munir, 2013). The last stage of application testing is carried out to test the usability aspect.

The testing comprises Alpha Testing and Beta Testing. Alpha Testing is carried out using a questionnaire to four experts, which includes two material experts and two media experts. The media validator validates the learning media product. They were learning media experts, namely Dr. H.K. Manggoppa, MAP, and Mario Parinsi, S.Kom, MTI. The validation results were scored by the multiplication of the number of answers. The feasibility presentation of the media expert validation results will get the maximum score obtained from multiplying the number of questions, the number of respondents, and the score 5. The maximum score is as follows:

Max Score = Number of questions x Number of respondents x 5
= 36 x 2 x 5
= 360

Percentage of Feasibility (%) = (Total score/score max) x 100%
= 322/360 x 100%
= 89.44%

The percentage of eligibility according to the calculation results is 89.44%. This quantitative value is converted into a qualitative value based on the media rating scale. The media expert test is obtained with an interpretation of "very feasible".

The material validator validates the Digital System material which will be presented in web-based learning media. The validation was carried out by two material experts, namely Dr. Ir. V.R. Palilingan, M.Eng., and Dr. Jimmy Waworuntu, MS.

The results of the calculation of the score will present the feasibility of the material expert validation as follows:

Max Score = Number of questions x Number of respondents x 5
= 38 x 2 x 5
= 380

Percentage of Feasibility (%) = (Total score/score max) x 100%
= 345/380 x 100%
= 90,78%

The percentage of eligibility is 90.78% This quantitative value is converted into a qualitative value based on a rating scale. The expert testing is obtained with the interpretation of "very feasible".

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Beta testing is testing the user to determine the user's response to the product. This beta test involved three students at the second semesters of PTIK Department, Faculty of Engineering, UNIMA.

The results of the score calculation will get a presentation of the feasibility of the field test results as follows:

Score max = Number of questions x Number of respondents x 5
= 28 x 3 x 5
= 420

Percentage of Feasibility (%) = (Total score/score max) x 100%
= 367/420 x 100%
= 87,38%

The percentage of the feasibility of field test results according to the calculation results is 87.38%. This quantitative value is converted into a qualitative value based on a rating scale. The field testing is obtained with an interpretation of "very feasible".

The resulting product feasibility of web-based learning media is a total assessment with the unit testing and acceptance testing. The results of the unit testing is a 100% feasibility percentage (very feasible category), while the acceptance testing consisting of Media and Material Expert Test and Beta/User Test resulted in a percentage of 89.44% (very feasible category) for testing by media experts, 90.78% (very feasible category) for testing by material experts, and 87.38% (very feasible category) for user testing.

The development of learning media must meet its main rules and requirements. Its main components must meet the cognitive aspects, attitudes, general skills, and special skills (Arsyad, 2013). The material developed in the learning media product must be in accordance with that students learn. In this study, we have succeeded in developing digital learning media by paying attention to the material according to the learning objectives prepared by the teachers. The material is simply in accordance with the topic including the introduction of computer and information technology as a basis and insight for students to use this website-based learning media easily (Simarmata, 2006). Specific materials such as digital circuits can be included as topics in one or more planned meetings (Muchlas, 2005). This is important to ensure students can use this digital learning media perfectly.

In the process of developing digital learning media, it is necessary to consider the devices used by students. Currently, the majority of students use mobile phones as the main device to access the internet. The mobile phones play a significant role in improving student learning outcomes (Aripin, 2015). Therefore, the choice to use the website as a technology platform to develop learning media is the right choice. This underlines that digital learning media has a big role as a source of learning for both students and teachers (Musfiqon, 2012). This is also evident in research that has been carried out by several researchers who found that digital learning media has a great influence on student achievement, so it is important to develop it into learning media that are

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continuously used in learning activities (Kamasi, 2017). Learning media based on mobile phones was also found to have a significant influence on student learning outcomes (nikmah, 2012). Thus, it is very important to build digital learning media to improve student learning outcomes.

The use of website-based digital learning media must be in accordance with learning and its principles, specifically learning methods and models in computer science. This is important to make the learning objectives achievable by using appropriate learning models and methods (Rusman, 2018). The development of learning media must also be in accordance with research methods and procedures to ensure its excellent and reliable quality, good functionality, and high usability (Sugiyono, 2015). In the development process, various tools can be used. Some researchers use Adobe Flash + XML to build learning media (Sunyoto, 2010). This is certainly very good in producing learning media products with good quality.

We have succeeded in developing digital learning media well. Several other researchers have also developed mobile phone-based learning media and produced a good mobile learning product (Traxler & Vosloo, 2014). This shows that there are many options to build digital learning media. Developers can choose according to the context, learning environment, and available information technology infrastructure. Other researchers have also succeeded in building website-based e-learning which can also be applied to m-learning (Wirawan, 2011). This is very interesting to observe because it is a good breakthrough because it can combine e-learning and m-learning. This is also in line with other researchers who have also succeeded in developing e-learning learning media and successfully implemented it in vocational high schools (e.g., Atmanegara & Rusimamto, 2016). This shows that information technology can provide adequate learning media to enable the learning take place in a quality manner (Yusuf, 2005). The results of our research have succeeded in showing that with adequate methods, techniques, and tools, quality digital learning media can be built and easily implemented in learning activities for in-person and remote learning.

CONCLUSIONS

The results of this development research are web-based learning media products in the Digital System course. The final results of any tests performed on the media web-based learning in the subject Digital Systems showed a very decent result. The feasibility percentage that meets very decent interpretation indicates learning media is very feasible to use.

Based on several tests carried out, web-based learning media products for the Digital System course are appropriate to be used as learning media. Product revisions are obtained after testing and receiving some input from experts and product users to improve the product betterment and fit for use.

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REFERENCES

Arikunto, S. (2010). *Prosedur penelitian.*Yogyakarta: Rineka Cipta

Aripin, M. (2015). *Pengaruh handphone terhadap pelajar*. Retrieved 23 June 2017 from https://www.kompasiana.com/aripin63/54f372e37455137d2b6c7599/pengaruh-handphone-terhadap-pelajar

Arsyad, A. (2013). *Media pembelajaran.* Jakarta: Raja Grasindo Persada.

Atmanegara, W. P., & Rusimamto, P. W. (2016). Pengembangan media pembelajaran e-learning menggunakan Edmodo pada mata pelajaran Elektronika Dasar (Studi pada siswa Kelas X TEI SMK Negeri 2 Bojonegoro). *Jurnal Pendidikan Teknik Elektro, 5*(1), 359-364.

Fathikah F. Hanum, (2014). *Pengembangan media pembelajaran berbasis web untuk mata pelajaran Pendidikan Kewarganegaraan (PKn) di SMA Negeri I Banguntapan* (Bachelor's Thesis).Yogyakarta: Universitas Negeri Yogyakarta.

Kamasi, N. V. V. (2017). *Pengembangan media pembelajaran berbasis mobile learning di SMK Negeri Ratahan* (Bachelor's Thesis). Universitas Negeri Manado, Manado.

Khafit, A., Sulastri, S., & Fauzan, S. (2020). Technology Acceptance Model (TAM): measurement of e- learning use by accounting students at Malang State University. *Asia Pacific Journal of Management and Education, 3*(3), 64-72.

Maza, E. M. T., Lozano, M. T. G., Alarcón, A. C. C., Zuluaga, L. M., & Fadul, M. G. (2016). Blended learning supported by digital technology and competency-based medical education: A case study of the social medicine course at the Universidad de los Andes, Colombia. *International Journal of Educational Technology in Higher Education, 13*(1), 1-13.

Muchlas. (2005). *Rangkaian digital*. Yogyakarta: Gava Media.

Munir. (2013). *Multimedia: Konsep dan aplikasi multimedia*. Bandung: Alfabeta.

Musfiqon. (2012). *Pengembangan media & sumber pembelajaran*. Jakarta: Prestasi Pustaka Publisher.

Nikmah, A. (2012). *Dampak penggunaan handphone terhadap prestasi siswa. E-jurnal Dinas Pendidikan Kota Surabaya, 5*, 1-8.

Ponto, H. (2020). The evaluation of affective domain learning outcome in students basic learning of electrical circuit in vocational education school. *Journal of Computational and Theoretical Nanoscience, 17*(2-3), 1222-1226.

Pressman, R. S. (2001). *Software engineering: A practitioner's approach* (5th ed.). New York: McGraw-Hill Companies.

Rosa, A. S., & Shalahuddin, M. (2015). *Rekayasa perangkat lunak terstruktur dan berorientasi objek*. Bandung: Informatika.

Rusman. (2012). *Belajar dan pembelajaran berbasis komputer*. Bandung: Alfabeta.

Silveira Sonego, A.H., Rocha Machado, L., Wildt Torrezzan, C. A., & Behar, P. A. (2016). *Mobile learning: Pedagogical strategies for using applications in the classroom*. Paper presented at the International Association for Development of the Information Society (IADIS) International Conference on Mobile Learning (12th, Vilamoura, Algarve, Portugal, Apr 9-11, 2016)

Simarmata, J. (2006). *Pengenalan teknologi komputer dan informasi.* Yogyakarta: Andi Offset.

Sugiyono. (2015). *Metode penelitian dan pengembangan research and development*. Bandung: Alfabeta.

Sunyoto, A. (2010). *Adobe Flash + XML* = Rich multimedia application. Yogyakarta: Andi.

Traxler, J., & Vosloo, S. (2014). Introduction: The prospects for mobile learning. *Prospects: Quarterly Review of Comparative Education, 44*(1), 13-28.

Watkins, John.,& Simon Mills. (2011). *Testing IT*. New York: Cambridge University Press.

Wirawan, P. W. (2011). Pengembangan kemampuan e-learning berbasis web ke dalam m-learning. *Jurnal Universitas Diponegoro, 2*(4), 22-23.

Yuniati, L. (2011). Pengembangan media pembelajaran mobile learning efek doppler sebagai alat bantu dalam pembelajaran fisika yang menyenangkan. *Jurnal Penelitian Pembelajarana Fisika, 2*(2), 92-101.

Yusuf, M. O. (2005). Information and communication technology and education: Analysing the Nigerian national policy for information technology. *International Education Journal, 6*(3), 316-321.