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Development Modern Physics Digital Handout Based on Technology Literacy

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Abstract

This study aims to produce a valid and practical modern physics digital handout based on technology literacy through the adaptation of Rowntree product development model procedures and Tessmer formative evaluation on the physics education study program, FKIP, Sriwijaya University. The data was collected by walkthrough and questionnaire technique. The result showed the mean score for the validity of the digital handout was 4,53 for design, content, and linguistic aspects with a highly valid category. The practicality average score in the one-to-one evaluation stage and the small group evaluation stage were 79,08% and 84,59% respectively, both of them with practical category. Thus, the developed modern physics digital handout based on technology literacy was very valid and practical.

Keywords: *technology literacy, modern physics, digital handout*.

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INTRODUCTION

One factor that is supporting the procurement of science and technology into a significant indicator in improving the quality of education in the era of industrial revolution 4.0 today is the literacy level of human resources. Literacy, according to UNESCO (2008), is the ability to identify, understand, interpret, be creative, communicate and compute using printed and written materials associated with varying contexts. Literacy must be able to shape students' abilities in analytical, synthetic, evaluative, critical, imaginative, and creative thinking (Liansari & Nuroh, 2018). UNESCO also assigns six components that include: education policy, curriculum and assessment, pedagogy, ICT, organization and administration, and teacher professional development based on three aspects: technology literacy, knowledge deep, and knowledge creation in the education system that is expected to become the competence of teachers in the current era of globalization.

Technology literacy became one dimension of literacy within the National Literacy Movement Guide (2017) issued Kemendikbud. Colorado Department of Education (CDE) defines technology literacy as the ability to responsibly using appropriate technology to convey or communicate, solve problems, access, manage, integrate, evaluate, design and create information to improve learning in all subject areas and gain knowledge for

life and skills in the 21st century. Technology literacy, according to Nasution (2018) is also defined as the ability with consists of aspects of science, critical thinking skills, as well as decision-making in an effort to utilize the technology/innovation man's work effectively, especially in the world of education.

In technological development, modern technologies closely linked to the development of modern science. Especially physics for examples in the health sector there are Endoscope, Cystoscope, Practoscope, and Otoscope (Serway, 2010).

Modern physics become a compulsory subject for students of the fifth semester in the Physics Education Study Program, Sriwijaya University with a credit load of 3 credits. Each concept of the subject matter of Modern Physics materials to be taught, especially Relativity and Particle Wave Dualism have many applications on technology. But the facts on the ground found by the researcher during the lecture, a few books into the teaching materials of this subject explains the concepts in terms of mathematical operations and less support for the improvement of the students' technology literacy. So many students are still difficult to understand the concept of Modern Physics, especially its application on the technology. Although the handout of Modern Physics study has been developed before by (Septariyani, Pasaribu, & Akhsan, 2018; Virginia, Pasaribu, & Akhsan, 2018). However, these two modern physics handout studies aren't presented in digital form and aren't yet based on technology literacy so that they have not become a solution to improve students' technology literacy.

Based on the results of filling the online questionnaire by the student of Physics Education Study Program 2016 Sriwijaya University in mind 64.5% of the students stated the difficulties caused by the lack of discussion of the concept of additional reference points on the application of Modern Physics material application in technology. It is necessary to develop teaching materials such as handouts that its contents will be more focused on the discussion of the concept of the material points of Modern Physics on its application on the technology. In the globalization era, the presentation of handouts can be delivered in digital form such as digital books that can be opened easily in electronic devices such as gadgets, PCs, notebooks, etc. The virtual screen of other innovations in the presentation of images, audios, videos, or hyperlinks on the research that has been done by (Lestari, Adi, & Soepriyanto, 2018; Mawarni & Muhtadi, 2017; Mentari, Sumpono, & Aceng, 2018; Putrawansyah, Zulkardi, & Siahaan, 2016; Syafruddin, 2019). The aim of this study will develop valid and practical Modern Physics digital handout based on Technology Literacy as one of the digital learning resources (combined elements of hardware and software) that have the potential to be able to overcome the problem of learning and facilitate learning activities (Dopo & Ismaniati, 2016).

METHOD

This research was conducted in Physics Education Study Program, FKIP, Sriwijaya University from August to December 2019. The development research method and Rowntree product development model that has three stages: planning stage, development stage, and evaluation stage are used in this study. At the evaluation stage adopted Tessmer formative evaluation procedure consisting of five stages: (1) self-evaluation; (2) The expert review; (3) one-to-one evaluation; (4) small group evaluation; (5) field test. But the field test stage in this study was not performed because the purpose of this study only to see the validity and practicality of the product.

In the planning stage needs analysis done by filling a simple online questionnaire. Filling this questionnaire aims to find out the existing problems in

the field related to the study of modern physics course. Data collection techniques used in this study are walkthrough (to see the validity of the product) and questionnaire (to see the practicality of the product). The data collection tool that is used in the walkthrough technique is the validation sheet given to the expert or validator at the stage of the expert review. There are two validators to validate three aspects (design, content, and linguistic). The questionnaire technique was conducted at the one-to-one evaluation stage and small group evaluation stage involving students in Physics Education 2016 Indralaya class as many as 32 people. The students responses questionnaire consists of 11 indicators, they are clarity of use instructions, clarity of information, the suitability of students needs, giving motivation, benefits to add insight, use of fonts (type and size), effective and efficient use of language, innovation in pictures, videos, illustrations, audio, and website links, display design, layout, and detailed study of material concepts about their application in technology. The results obtained through walkthrough and questionnaire techniques analyzed using a Likert scale to measure how an expert opinion and students on the use of digital handouts. Likert scale used is made in the form of a checklist with five response categories shown in Table 1.

Table 1 Validation and Questionnaire Scoring Criteria

Answers Category	Statement Score
Strongly agree	5
Agree	4
Doubtful	3
Disagree	2
Strongly Disagree	1

(Sugiyono, 2015)

The results of the validation from the validator will be presented in tabular form. Then searched the average achievement of digital handouts validity of the statement score with the average formula (Riduwan, 2011).

$$x = \frac{\Sigma Xi}{n} \quad \text{.... (1)}$$

Information:

x = average value of the validity of the handout

ΣXi = number of scores obtained

N = number of statements

The average results of the assessment of the validator obtained then adjusted in several categories as shown in Table 2.

Table 2 Expert Validation Score Criteria

Average Value	Category
$4 \leq AVS \leq 5$	Very Valid
$3 \leq AVS < 4$	Valid
$2 \leq AVS < 3$	Less Valid
$1 \leq AVS < 2$	Invalid

Note: AVS = Average Validity Score

(Destiani, Ismet, & Wiyono, 2017)

Data from the questionnaire will be presented in tabular form and percentages. Researchers then can know the results of the questionnaire in accordance with criterias that have been assigned in Table 3.

Table 3 Score Criteria of Students Practicality Responses

Response Value Percentage (%)	Category
$86 \leq FSSR \leq 100$	Very Practical
$70 \leq FSSR < 86$	Practical
$56 \leq FSSR < 70$	Practical enough
$0 < FSSR < 56$	Less Practical

Note: FSSR = Final Score of Students' Response

(Riandry, Ismet, & Akhsan, 2017)

Comments and suggestions provided by experts and students written on a sheet of validation and the questionnaire. Comments and suggestions taken into consideration to improve the digital handouts.

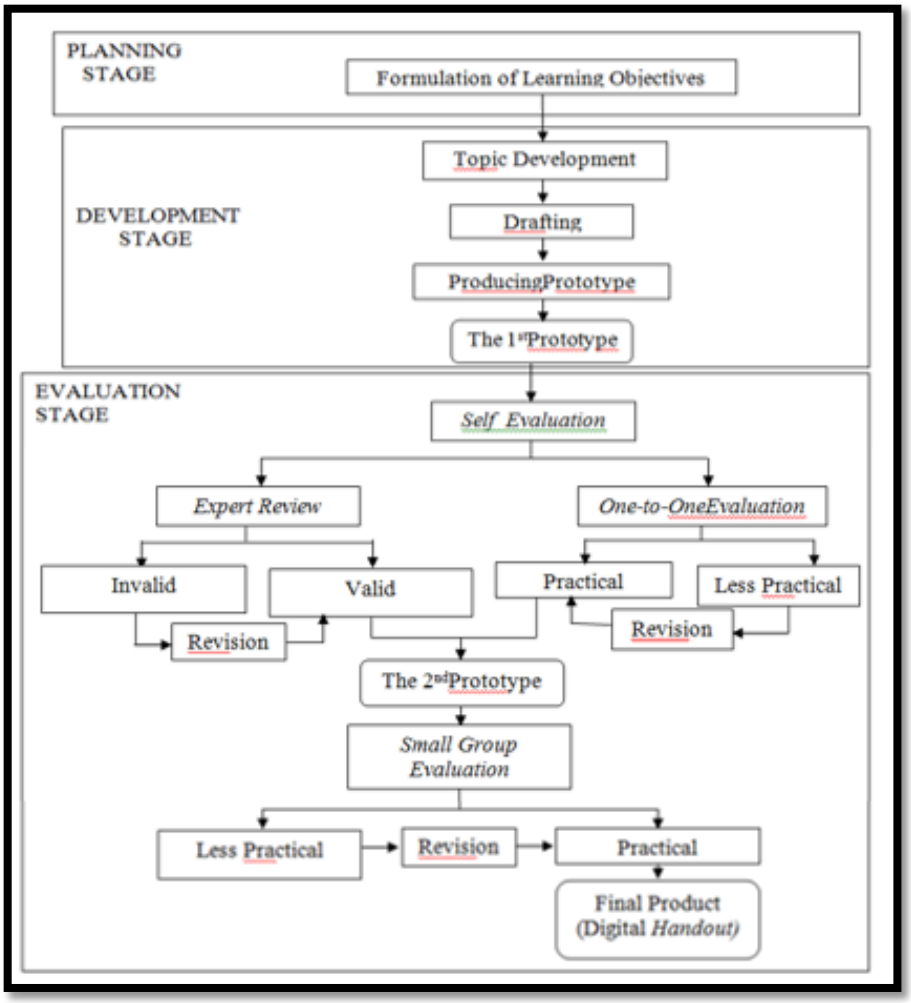

Figure 1 Modern Physics Digital Handout Based on Literacy Technology Development Procedure (adopted from Rowntree and Tessmer)

RESULTS AND DISCUSSION

Planning Stage

Technology be an option required to be applied in education, not only in the context of general education but also penetrated special education, namely learning (Helaluddin, 2019) for it at this stage done a needs analysis and the formulation of learning objectives related to mastery technology. The results obtained on a needs analysis showed that 64.5% of the students expressed difficulty in learning the material, especially on the concept of Modern Physics that has applications on technology due to the lack of reference. 80.6% stated the teaching material needed were in the form of digital handouts..

Formulation of learning objectives by analyzing the semester program plan of Modern Physics courses by developing indicators of learning achievement and the ability to end a predetermined learning outcomes at the Physics Education Study Program at Sriwijaya University. Besides, the analysis also carried the material so obtained material suitable to be developed in a Modern Physics digital handout based on technology literacy is Einstein's relativity and particle-wave dualism which focus on understanding concepts in the application on the technology.

Development Stage

The development stage is done by developing a topic, drafting and producing prototypes (Prawiradilaga, 2007). Development of the topic done by creating an Outline of the Content of Digital Handout based on the description of the material obtained from the learning objectives that have been formulated before then used to construct a storyboard. Drafting is done by determining the components that will be included in the digital handouts. Production of the prototype is done by making products in the form of Modern Physics digital handout based on technology literacy as a prototype-1 (the initial product). The application used is 3DPageflip to convert existing pdf files, to obtain a digital display and add images, videos, audio, hyperlinks, flash, and the buttons and their functions. Digital handout produced is supplementary teaching materials for other teaching materials because the materials presented focused on the application of the concept of Einstein's relativity and particle-wave dualism in the application on the technology. On the matter of Einstein's relativity will discuss the application of modern physics concepts on GPS (Global Positioning System), Electromagnetic, and Nuclear Power Plant. As for the particle properties of the wave will be discussed the application of modern physics concepts in the fields of electronics such as TV, radio, telephone, in fields of health care such as an endoscope, cystoscope, infrared thermometer, mammography, CT-scan. For the wave properties of particles will discuss the application of modern physics concepts on electron microscopy and quantum dot technology.

Several display digital handout pages presented in the form of images. The cover page contains the title, the concept of relativity picture, name, and address of the author, as well as the on/ off music button and switch back and next page button are presented in Figure 2.

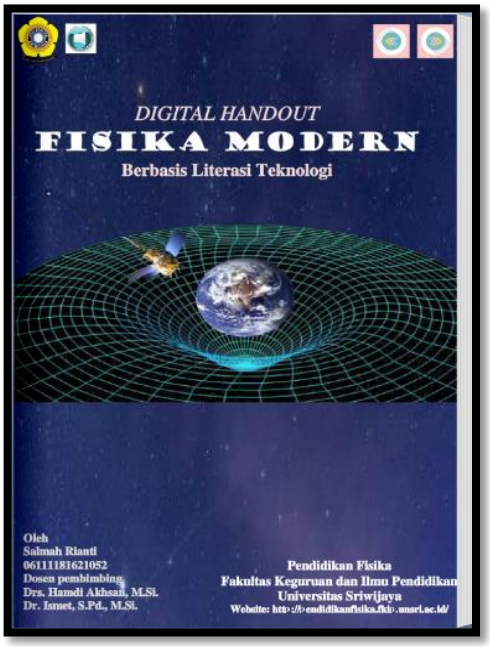

Figure 2 Digital Handout Cover

In the table of contents page, page numbers can be clicked directly on to the discussion of the desired material. If we click home button will return to the table of contents for easy towards the desired page, table of contents page views are presented in Figure 3.

Figure 3 Page Contents

Before entering the discussion of the material, on the home page of each chapter along with the picture presented a brief explanation that refers a question for further discussion as an introduction and presented sub material that will be discussed zoom as shown in Figure 4. Nearly the entire page has pictures and videos contents one of them as shown in Figure 5. when a video is playing, the display will be like in Figure 6 and when the image is clicked the display will be as in Figure 7. On some pages also contain more than one picture when it is clicked, the zoom will be 3D as in Figure 8 and if clicked on one of the images in the 3D view which has been selected for each pageview will come back as in figure 7. At the end of each chapter will be presented the "Let's think" box which contains questions and answers were on the hyperlink provided. See this page as in Figure 9, when it is clicked, and the computer has internet access then the intended article and video can be displayed.

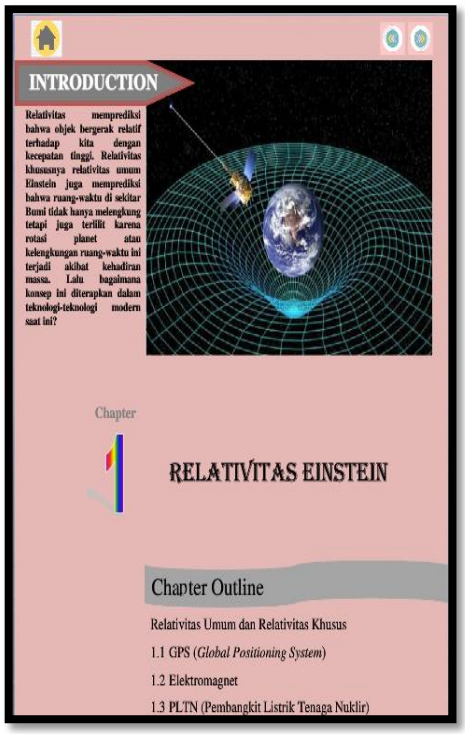

Figure 4 Home Page Display in Every Chapter

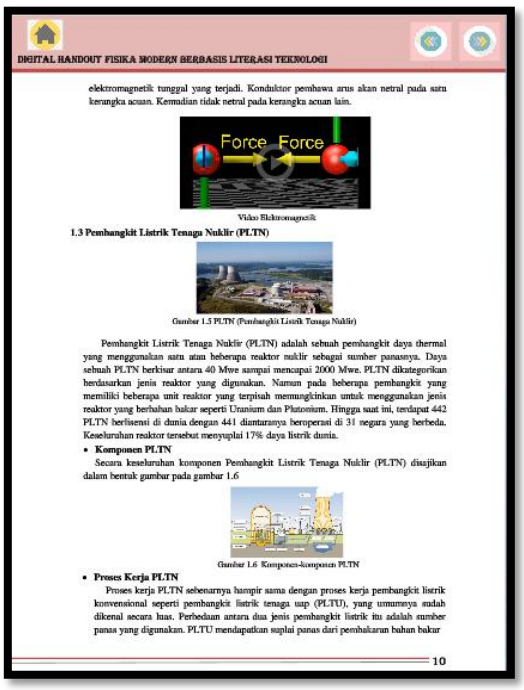

Figure 5 Contents Page Display Accompanied Video and Image

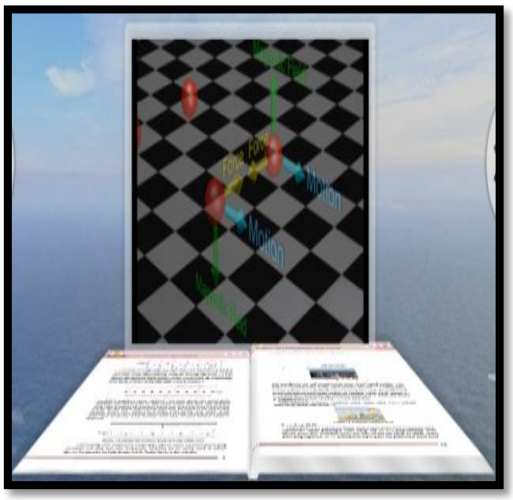

Figure 6 Page Display When Video Played

Figure 7 Page Display When Images Clicked

Figure 8 Page Display When Images More Than One Clicked

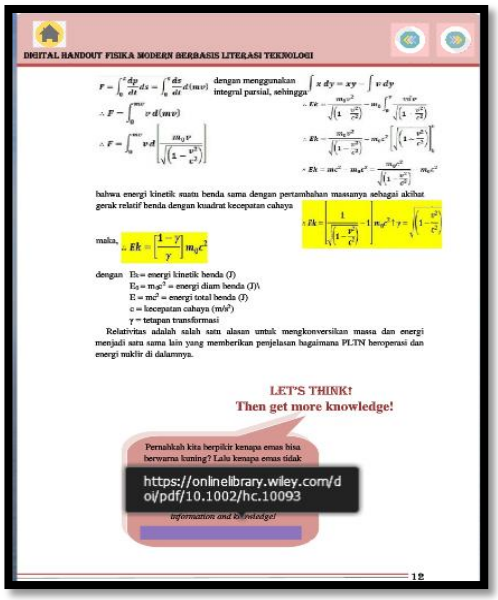

Figure 9 Page Display With Hyperlinks

Evaluation Stage

The evaluation stage is performed based on the stages of the Tessmer formative evaluation. The first step is self-evaluation, self-examination of aspects of content, design, and linguistic prototype-1 conducted with the supervisor. Thus obtained some suggestions for improvements and prototype-1 has been fixed in part; (1) color, text, and images cover; (2) margin and writing a page number in the list of images; (3) the color on a part that can be clicked in the table of contents is the list of images. The second stage of the expert review is conducted to evaluate and validate the three aspects of the design, content and linguistic prototype-1 involving several experts. The results of the validation of design, content, and linguistic are presented in tabular form in Table 4.

Table 4 Summary of Results of Expert Review Stage Assessment

Aspects Validated	Validity Value	Category
Design	4.04	Very Valid
Contents	4.82	Very Valid
Linguistic	4.75	Very Valid

Based on the results obtained in Table 4 in mind that the resulting product is very valid for all aspects validated where the mean value of the validity of the product amounted to 4.53 with the very valid category. The resulting product had a very valid point aspects of the content or materials of the product developed is already relevant to the achievement of competency standards, aspects of the design are sufficient to facilitate the achievement of learning objectives, and the grammatical aspect is consistent.

Furthermore, the stage of one-to-one evaluation with testing of the product to students of Physics Education 2016 Indralaya class who had taken Modern Physics subject. The results of these tests can be seen through the score questionnaire presented in tabular form in Table 5.

Table 5 The Results of One-to-One Evaluation Stage Assessment

Indicator	Amount Scores of Subjects	Percentage (%)
1	12	80
2	12	80
3	12	80
4	12	80
5	24	80
6	21	70
7	21	70
8	37	82.2
9	24	80
10	23	76.67
11	146	81.11
Average	344	79.08%
Category		Practical

Based on the results obtained in Table 5 in mind that the prototype-1 produced has practically. After going through the revision based on the results of consideration of the comments and suggestions of experts and the three of students produced prototype-2 that ready tested at the small group evaluation stage.

The small group evaluation stage is done by trying out the product to students who were divided into three small groups. This stage is carried out as a final evaluation stage of this study in an effort to produce a prototype-3 or the final product is a Modern Physics digital handout based on technology literacy. The results of the assessment questionnaire responses from nine students presented in tabular form in Table 6.

Table 6 The Results of Small Group Evaluation Stage Assessment

Indi-cator	Subjects									Total Score	Percentage (%)
	AA	DN	EM	EW	HA	IH	KW	M	VN		
1	3	5	4	5	4	5	4	4	5	39	86,67
2	4	5	4	5	4	4	5	4	5	40	88,89
3	4	4	4	4	5	4	5	5	4	39	86,67
4	5	5	5	4	4	4	5	4	4	40	88,89
5	8	8	9	8	9	8	8	9	8	75	83,33
6	6	9	8	10	9	10	8	8	8	76	84,44
7	8	9	8	9	9	8	9	9	9	78	86,67
8	10	14	11	11	13	11	13	12	14	109	80,74
9	6	9	8	10	8	8	10	8	9	76	84,44
10	7	9	8	10	9	8	10	8	9	78	86,67
11	53	56	48	48	53	46	52	46	52	454	84,07
Average										1104	84.59 %
Category											Practical

Based on the results obtained in Table 6 is known that the prototype-2 produced was practical. Practical in the sense of language means "easy to use in practice". This practical aspect can be assessed from the attractiveness, legibility, and advantages of the literacy base (Aisyah, Gipayana, & Djatmika, 2017). Positive comments are given by the students such as good, interesting, interactive, easy to understand and effective to use. Related to student retention of certain materials also increased. So not too many revisions made to produce a prototype-3 or the final product is Modern Physics digital handout based on technology literacy is already very valid and practical.

The overall results obtained are almost the same as previous studies which also developed modern physics handouts but were not packaged in digital form and not based on technology literacy.

Modern Physics Digital handout based on technology literacy has the advantage of presenting innovative print instructional materials are packaged in a digital form that can display videos, 3D images, hyperlinks and other supporting things that can not be displayed in the digital handouts printed and is more efficient because it can be taken anywhere and can be stored in external memory, drives, or clouds so that it can be opened anytime and anywhere. It also overcomes the nature of dependence instructional media in the classroom (textbook) and improves self-direct learning. According to Novanda (2019), Self direct learning is a method in learning which emphasis on the freedom, autonomy, and choice of people to find the information they need.

As well as the weakness that has not been observed because the effectiveness of the product has not been tested extensively (field test) and can only be

opened via a desktop/PC because the file is an exe format that can not be opened via the android/iOS. To be opened via the android/iOS then be shaped 3D file format that can be opened with a 3D application reader.

CONCLUSION

Has successfully developed a valid and practical Modern Physics digital handout based on technology literacy in Physics Education Study Program at Sriwijaya University. The validity of the product was very valid with an average conversion value for each aspect of the design (4.04), contents (4.82) and linguistic (4.75). Practicality products were practical with the results of the questionnaire responses overall assessment of students in the percentage reached 79.08% for one-to-one evaluation stage and at small group evaluation stage reached 84.59%. Similar research still needs to be done to find out the effectiveness of product through the field test stage and the use of other applications that are easier to open on android/IOS.

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