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# Development of digital handout of quantum mechanics no spin and quantum mechanics with spin using professional pdf flip app

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**Abstract.** This study aims to produce a digital handout on the subject of mechanics quantum mechanics without spins and quantum mechanics with spins are valid and practical. Development This digital handout uses a combination of Rowntree's development model and evaluation model Tessmer formative. The Rowntree development model consists of three stages, namely: planning, development and evaluation. The evaluation stage consists of four stages, namely: self evaluation, expert review, one-to-one evaluation, small group evaluation. Technique data collection in this study using walkthroughs and questionnaires. Research subject This is a student who has taken the introductory quantum physics class of class 2017 Indralaya class for the Physics Education Study Program, Sriwijaya University. Obtained the average score the average that meets the very valid category with a score on the content aspect of 4.92, the design aspect 4.46, and the language aspect 4.5. And meet the very practical category with an average score of 4.43 at the one-to-one evaluation stage and 4.52 at the small group evaluation stage.

## 1. Introduction

The faster the progress of science knowledge and technology in the field of information and new innovations in technology make it easy life human. Advances in science and technology make an impact on the world education, one of which is to increase quality of education so as to create quality human and answer market demand for labor quality [1]. Quality of education and learning outcomes influenced by many things, including educator skills and learning resources which will be used during the learning process teaching [2]. Source learning has a very important role in solving problems in learning, therefore learning resources are very important to improve the quality of education. One type of learning resource that is very often used are teaching materials.

Teaching materials are learning resources which serves to convey content or learning materials/lectures for encourage teacher efficiency and improve student performance [3]. With teaching materials to make learning more interesting, practical, and realistic. In addition, the use of teaching materials in learning allows good teachers or students can participate actively and make learning more effective. Teaching materials can provide space to acquire knowledge and skills, develop confidence self-actualization and self-actualization of students [3].

According to material teach has several types based on one of the technologies used namely handouts [4]. Handout is one of the types of printed teaching materials containing a summary of the material prepared by educators for make it easier for students to follow learning [5]. Handouts load the required parts for learning which consists of; destination, learning or competence, prerequisite namely



learning materials that support or need to be studied first beforehand, learning procedures, theory learning that arranged systematic, exercises or tasks and questions evaluation questions [6].

Great technological developments quickly create a paperless culture or paperless in the form of teaching materials/handouts print using paper and ink, as if immersed in the discovery of teaching material electronic (Digital Handout), so that more varied and innovative teaching material scan be equipped with hyperlinks, images as well as videos assisted with use a professional PDF flip application to get a digital display that sophisticated.

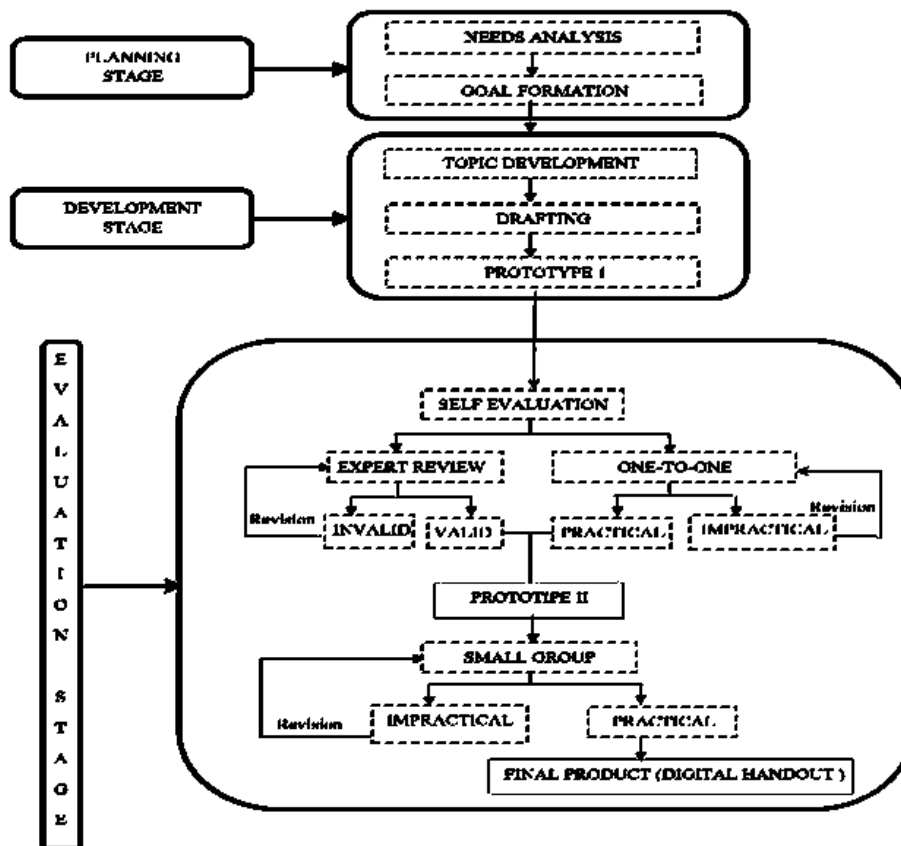
Development technology especially high technology has very close relationship with development of science, especially physics quantum. Main concept Introduction to Quantum Physics can used to develop or create new technology if studied furthermore. However, some references learning resources used in teaching and learning process for subjects it's dominant in English so that if some terms are direct translated can give meaning doubles as well as references used too only focused on understanding the concept only the material so it's very minimal to help improve literacy student technology. Therefore, many students experience difficulty understanding the concept Introduction to Quantum Physics especially on its application in the field of technology.

Based on the results of filling out the questionnaire online with google from by 41 student class 2017 physics education Indralaya, then the results obtained are 43.9% of students who have difficulty caused by book references that used in language learning english. 61% stated strongly agree and 39% agree if done similar development research.

Research and development of teaching materials has been carried out by several researchers in UNSRI, including 1) [7] with products in the form of digital handouts based on technological literacy in courses modern physics the subject of relativity and particle wave dualism [8] with a product in the form of a textbook introduction to STEM-based quantum physics in the spin sub-topic. 3) [9] with products in the form of -based modules STEM subject matter variation potential in the introductory course quantum physics. While in research in this case, researchers will develop digital handout on introductory physics course quantum subject of quantum mechanics without spin and quantum mechanics with technology literacy-based spin because the lack of development of teaching materials accessible electronics and materials quantum mechanics without spin and mechanics quantum with integrated spin with technological literacy.

## 2. Methods

Research this done in Education Study Program Laboratory Sriwijaya University Physics with use method research Rown tree model product development. According to [10] model Rown tree development consists of 3 stages, that is step planning, step development and evaluation stage. On evaluation stage using the evaluation model Tessmer formative consisting of (1) self evaluation ; (2) expert review ; (3) one to one evaluation ; (4) small group evaluation and (5) Field Test [11]. But stage the fifth is not done because the purpose is to be achieved in this research only to produce digital handout products valid and practical.



**Figure 1.** Research Development Procedure (Rowntree and Tessmer)

Then for the gathering technique the data uses a walkthrough to see the level of product validity and questionnaires to see the level of practicality of the product. In walkthrough data collection techniques the data collection tool is in the form of sheets validation given to experts who includes content, design, and language validation. With guided validation indicator son the Guide to Development of Teaching Materials by the Ministry of National Education (2008). Indicators that validated for the content aspect, namely suitability material with achievements and indicators learning, the truth of the substance of the material, suitability to student needs, conformity with digital needs handouts, benefits to add insight knowledge and detailed study of material concepts about its application in technology. Validated indicators for design aspects consists of completeness of information, sequence presentation, use of fonts (type and size), Illustration, image, audio, video, linkweb, layout and display design. Validated indicators for language aspect consists of legibility, clarity of information, conformity with the rules of the Indonesian language good and correct as well as the use of language effectively and efficiently.

For data collection techniques a questionnaire in the form of a student response questionnaire given at the one-to-one stage evaluation and small group evaluation that involving 41 physics education students Indralaya class 2017. Sheet validation and questionnaire given later made in the form of a Likert scale. Scale The likert used is made in the form of checklist with five categories of answers such as the table below which is useful for analyze the results of the walkthrough and technique questionnaire.

**Table 1.** Criteria for Scoring Validation and Questionnaire [12].

Category Answer	Score Statement
Very good	5
Good	4
Doubtful	3
Not good	2
Not very good	1

Validation results and questionnaire data will be described in tabular form. Then in calculate the average score with the formula [13].

$$\bar{X} = \frac{\sum X}{n} \quad (1)$$

Description:  $\bar{X}$ = average score,  $\sum X$ = total score of each indicator, n = total statement.

The average value of validator and customized questionnaire data with the criteria set out in table 2 below:

**Table 2.** Criteria for Expert Validation Scores and Student Practical Response [14].

Average Score	Category
$4 \leq \bar{X} \leq 5$	Very valid
$3 \leq \bar{X} < 4$	Valid
$2 \leq \bar{X} < 3$	Not valid
$1 \leq \bar{X} < 2$	Invalid

Suggestions/comments received on the validation sheet and the questionnaire is used as input to fix digital handouts.

### 3. Result and Discussion

#### 3.1. Planning Stage

At this planning stage, it begins by conducting a needs analysis using a questionnaire via google form, the result is 100% students have difficulty in learn Introduction to Quantum Physics especially regarding the main concepts introduction to quantum physics on its application in technology. These difficulties are due to: (1) as many as 43.9% of students experienced trouble caused by book reference used in learning speak English, (2) 31.7% of student shaving trouble due to lack of additional book references regarding the discussion of the main concepts introduction to quantum physics on applications in the field of technology, (3) 24.4% of students have difficulty caused by the material presented is not associated with the application of its application in technology field. Another reason why this research was conducted based on previous research there are no researchers who develops course handouts introduction to quantum physics in particular the subject of quantum mechanics without spin and quantum mechanics with a spin that integrated with technological literacy as well as no researchers have packaged handouts in digital form.

Next after analysis needs, researchers formulate learning objectives that produce learning objectives and achievements from the results material analysis based on RPS analysis introductory quantum physics course. Materials presented on digital handouts this will focus on understanding the concept introduction to quantum physics on application in technology.

### 3.2. Development Stage

At this stage, the researcher conducts topic development, drafting and producing prototypes. First on the development of the topic the researcher conducts Creating an Outline of Contents for a Digital Handout (GBIDH) based on the topic of discussion developed based on destination learning that has been formulated. Then the drafting is carried out by specifying the components which will be written in the digital handout. The next step is prototype production1 or the initial product. Digital handout that produced in the form of supporting teaching materials with material focused on application its application in the field of technology on the concept of quantum mechanics without spin and mechanics quantum with spin.

Here's a digital handout display in image form. In figure 2 is a digital handout cover that contains the title, name of the researcher and the institution.



Figure 2. Cover

Prior to discussing the material, there is figure 3 which shows when hyperlink is clicked in the list section contents and other posts that go directly to additional reading resources and so on. There is also a page view that has figures and videos are shown on the figure4, when the image is clicked then as in display figure 5, while typing video rotated as shown in figure 6. Next on the practice questions at the end discussion there is a barcode that can scanned to make it easier for users to fill in the answer to the question, which is displayed on figure 7.

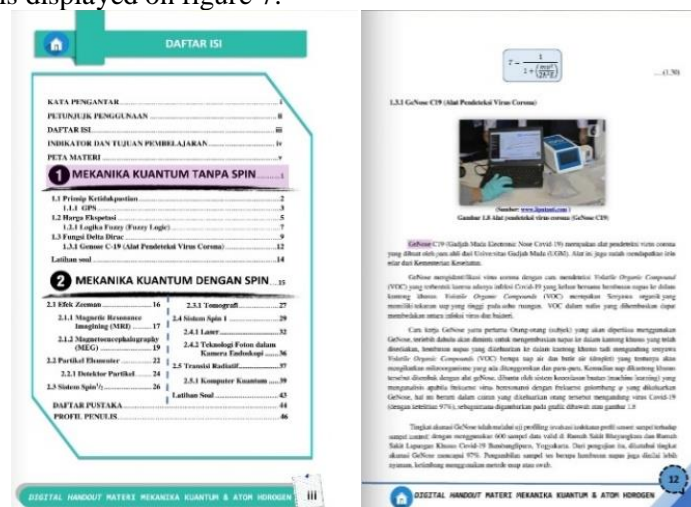


Figure 3. Page display with hyperlinks

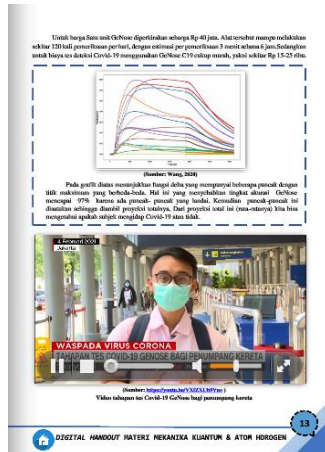


Figure 4. Page view with images and videos

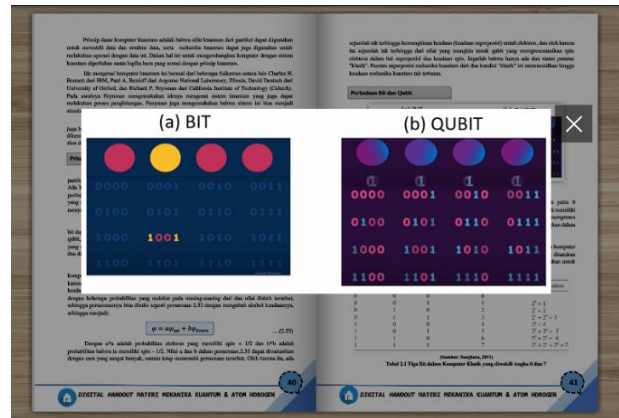


Figure 5. Display when the image is clicked

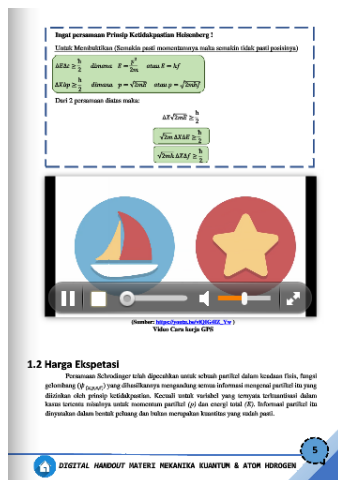


Figure 6. Display when the video is playing



Figure 7. Display the barcode of the question

### 3.3. Evaluation Stage

After prototype 1 is generated then the next stage is evaluated based on Tessmer's formative evaluation stages consists of four stages. First stage self evaluation that is self-examination to the initial prototype draft that has been developed and checked by lecturers supervisor, as for enter the provided in the form of cover repairs, addition of sub chapters and additions using hyperlinks in digital handouts to make it easier to use. The second is expert review stage conducted by experts (Lecturer of Physics Education Study Program UNSRI) to see the level of validity in terms of content , design and language prototype 1.

Table 3. Recapitulation of Research Results Phase Expert Review

Aspects that validated	Score validity	Category
Contents	4.92	Very valid
Design	4.46	Very valid
Language	4.50	Very valid

Based on the table above, it can be it is known that the average yield obtained from the expert review stage on each aspect has fulfilled very valid category, so digital handouts that have been developed already relevant to learning outcomes, aspects of the design is already attractive and adequate for used, and the language aspect has been consistent.

The third stage is one-to-one evaluation involving three people UNSRI physics education student class of 2017 Indralaya class who have take an introductory physics course quantum.

**Table 4.** Research Results Phase One-to-one evaluation

Indicator	Average Score	Category
1	4.67	Very Practical
2	3.60	Practical
3	4.30	Very Practical
4	5.00	Very Practical
5	5.00	Very Practical
6	4.00	Practical
7	4.67	Very Practical
8	4.67	Very Practical
9	4.00	Practical
10	4.17	Very Practical
11	4.67	Very Practical
Score Average	4.43	Very Practical

Based on table 4, it is known that the resulting prototype 1 has practical, with suggestions / comments obtained from the stage of expert reviews and one-to-one this be input for revising the prototype 1 so as to produce a prototype 2 which will then be tested at the stage small group evaluation.

The fourth stage is small group the ninth trialed evaluation UNSRI physics education students class of 2017 Indralaya class who have take an introductory physics course quantum. This evaluation stage is the final stage of research for produce prototype 3 (Digital handout based on technological literacy of the subject quantum mechanics without spin and mechanics quantum with a valid and practical spin). The result data from this evaluation can be seen in table 5.

**Table 5.** Small Group Stage Research Results Evaluation

Indicator	Average Score	Category
1	4.60	Very Practical
2	4.60	Very Practical
3	4.20	Very Practical
4	4.40	Very Practical
5	4.40	Very Practical
6	4.40	Very Practical
7	4.60	Very Practical
8	4.50	Very Practical
9	4.60	Very Practical
10	4.60	Very Practical
11	4.80	Very Practical
Score Average	4.52	Very Practical



Based on the results obtained in the table above, it is known that the prototype 2 is already practical. Practical means that the resulting product is easy used, have clear instructions, and is in accordance with linguistic standards [15]. At this stage there is also suggestions/comments given are only in the form of fix one of the pictures the resolution is a bit low. From enter it produces prototype 3 as the end product is a digital handout on the subject of quantum mechanics without spin and quantum mechanics with a spin that valid and practical.

Digital Handout on the subject quantum mechanics without spin and mechanics quantum with developed spin with this professional PDF flip application has advantages, namely, 1) Teaching materials that don't just stick to writing, but with this Professional PDF flip app hyperlinks can be inserted as well as various multimedia content such as audio, animation, and videos [16]. 2) Format the output or output is flexible, such as html, exe, zip, Mac App, mobile version (IOS/Android) and inserted into the CD, making it more efficient to carry and used [17]. While the weakness of this digital handout is that every three months must be updated or uploaded back, with a maximum of one flip account Professional PDF upload three times product [18] and can't yet observed the effectiveness of this digital hand out broad because it has not been tested field test.

#### 4. Conclusion

Digital has been successfully developed quantum mechanics handout without spin and quantum mechanics with spin in Physics Education Study Program a valid and practical UNSRI. Average score the validity of the product meets the category very valid with each score on the aspect content validation is 4.92, design aspect is 4.46, and language aspects 4.50. Product practicality meet the very practical category with the overall results of the questionnaire assessment of the three students with an average score of 4.43 for the one-to-one evaluation stage and at the stage small group evaluation with results overall assessment of the questionnaire from the nine students with an average score 4.52.

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