

## The development of digital comics to explain the photoelectric effect through biographies and history

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**Abstract.** This research aims to produce comics in digital format to explain the photoelectric effect differently: variations between biographies and history. The method used in this study follows the steps: (1) literature study, (2) planning, (3) comic development, (4) validation test, (5) revision of validation test, (6) product trial, (7) Product revisions, and (8) comic application final products. The digital comics developed are comics that modify language texts, designs, and illustrations of the photoelectric effects of physical phenomena, which contain the history of the development of photoelectric effect phenomena starting from initial discoveries to the photoelectric effect theory that already exists today. Besides, it has an exciting plot because the concept of the photoelectric effect is conveyed through the history of photoelectric effects research and tells the life history of the inventors of the photoelectric effect phenomenon. This comic is packaged in the form of an android application.

### 1. Introduction

Based on the "Most Littered Nation in the World" study conducted by Central Connecticut State University in March 2016, Indonesia was ranked 60 of 61 countries related to reading interest. Indonesia is exactly below Thailand (59) and above Botswanan (61) [1]. The government efforts to overcome the factors that can hamper the reading interest of Indonesian children. The School Literacy Movement is one of the government's efforts to improve the reading culture of Indonesian children. The program launched by the Ministry of Education and Culture since 2015 is an embodiment of the Minister of Education Regulation No. 21 of 2015 concerning Character Building (PBP), one of the student activities that must be carried out is reading non-lesson books 15 minutes before class time starts [2]. Besides that, another effort made by the Ministry of Education and Culture to improve reading culture is to have formed 31 literacy villages from the target of 514 literacy villages, which will be completed in 2019 [3]. The efforts of the DKI Jakarta provincial government to improve reading culture, namely, the existence of a library built in the Child-Friendly Integrated Public Space, which has begun to be inaugurated in various places in DKI Jakarta since 2015.

Today's communication technology has developed very rapidly. Gadget trends continue to develop in Indonesia. Sophisticated technological gadgets such as smartphones, computers, tablets, and laptops are increasingly developing along with the increasing human need for modern and practical media. One use of technological developments to facilitate access to learning is to form printed comics online. The statistics from one of these platform applications, namely Webtoon notes that there are 6 million active LINE Webtoon readers as of August 2016 [4]. Online comics also have the same function as

printed comics, which are new learning resources for students. NTV Sekai Banzuke (world ranking) states that Indonesia ranks second in the world for the number of readers of manga (Japanese comics). Indonesia is just below Finland as the most manga reader with an average number of one reading almost four manga books. While Japan it is ranked 16th with an average value per person, only reading 1.5 manga [5]. Judging from the many students who like to read comics as well as the Indonesian ranking in reading manga, making comics as an alternative medium can be used to understand physical phenomena and can be used as reference readings by students.

Physical phenomena can be integrated directly into a comic whose storyline is modified in such a way that students when reading comics unconsciously directly learn the existing physical phenomena. The unconscious processes range from registering information in the sensory memory to formally forming associations within or between information patterns and activating associative memory networks, including individual expectations, beliefs, and desires [6]. The process of learning starts from getting information in sensory memory unconsciously to form mental associations with or between information patterns and can activate associative memory networks, including individual expectations, beliefs, and desires). Online comics about physics phenomena can be used as one of the innovations of educational media in learning physics, which is one of the applications of learning done unconsciously by students.

Another advantage of comics is that the presentation contains strong visual and story elements. In processing a knowledge visually, the human brain will process information more quickly, even up to 60,000 times than the text is read [7]. This fact is actual because nearly 50% of the human brain is involved in visual processing and 70% of all sensory receptors located in the eye, the brain only takes 150 milliseconds to process a symbol but 100 milliseconds to interpret it [8]. This time is much faster than the time needed to read and understand instructions in the text [9]. Therefore, visuals are easier to remember and process by the brain. The visualized expression makes the reader emotionally visible so that the reader continues reading it to the end. It also inspires comics, which contain subject matter. The tendency is that students do not like textbooks, especially those that are not accompanied by exciting pictures and illustrations. Empirically students tend to like picture books, which are colorful and visualized in both realistic and cartoon forms. Learning comics are expected to be able to increase students' interest in reading so that they can ultimately improve student learning outcomes [10].

The stages of engagement in each learning syntax are essential. Previous research shows that the implementation of comics for engaging teenagers with science through comics [11]. It describes how bridging problems engage students in unusual ways, namely by the power of visuals and stories in comics. Another research shows that the material presented in the form of comic books can improve students' remembering abilities [12,13]. Comic media are believed to have a hidden impact [14,15]. However, all findings on the influence of the use of comic media in learning still need to be done. In our paper aims to describe the design and development of comic based on biography.

The comics developed in this study combine the exploration of forms of how to develop comics and presentations in Android applications. It modifies language texts, designs, and illustrations of the phenomenon of physics photoelectric effects. Besides, online comics developed to have an exciting plot with a historical discussion of the photoelectric effect and are not fixated on formulas but are contextual in their daily lives.

## 2. Method

The method used in this study follows the steps: (1) literature study, (2) planning, (3) comic development, (4) validation test, (5) revision of validation test, (6) product trial, (7) Product revisions, and (8) comic application final products.

### 2.1. Research and information collecting

At this stage, a literature study is conducted to examine the basic competencies of the photoelectric effect material, which is: to analyze qualitatively quantum phenomena that include the nature of black body radiation, the photoelectric effect, the Compton effect, and X-rays in everyday life. After that

examining the history of the photoelectric effect phenomenon, scientists conducting research related to the photoelectric effect phenomenon of physics learning.

### 2.2. *Planning*

The resulting product is expected to meet various characteristics, namely using language and stories that are easily understood, complemented by interesting illustrations of the phenomenon of photoelectric effect physics, which contains the history of the development of the photoelectric effect phenomenon and has an interesting plot to understand the phenomena of physical physics and tell the life history of the inventors phenomena photoelectric effect.

### 2.3. *Develop a preliminary from of product*

The writing of the script is made after the assessment of basic competencies regarding the photoelectric effect. After that, researchers conducted information searches from various sources to find out the historical flow of the discovery of the photoelectric effect. In the script, the dialog design is specified, a detailed picture of the scene, and the number of panels per page. This script can still change when adjusting panel implementation is done by making basic sketches. The basic comic sketch illustrates the laying of the panel and a simple picture of the scene. Basic sketching is done using a pen tablet. Western image types (The Avengers, Captain America, Marvel, Superman, Batman, Garfield) are currently popular among teenagers. After the basic sketch is made, the next step is to make comics sketch as a whole. This excellent sketch was also made digitally using a tablet. Finer sketches and drawings made in detail when compared to basic sketches. The results of the finished sketches are then performed inking (thickening), which is to thicken the sketches that have been made. Inking is done using the SAI Paint tool application. The file is saved in the .png extension. The coloring phase is done using the SAI Paint Tool program which is a digital coloring standard program [16]. After the image is ready, the panel and text are entered with the Adobe Photoshop CS6 program. The typeface used for this online comic writing is VTC Super Market Sale. Besides that, the fonts used in Times New Roman and Arial are adjusted according to the function of the text.

## 3. Results and Discussion

### 3.1. *Description of the results of the development of comics*

The product produced from this research is an online comic application regarding the photoelectric effect phenomenon for the Android system. This media is intended high school students as a physics education media on the photoelectric effect material. The resulting comic is a physics history comic about research related to the photoelectric effect phenomenon. Physics phenomena are integrated directly into comics whose storylines are modified in such a way that students when reading comics unconsciously, directly study existing physical phenomena. In this comic application, the comics as a whole, such as comics about, character recognition, comics, summaries, attachments, bibliography, share applications, and comic book developers. In the beginning process of drawing, some steps finished by Comicker application [17]. Figure 1 shows some drawing pages of comics.

### 3.2. *Description of the results of the development of comics*

After all the comic sheets have been made, then the packaging is done to make the comic into an android application. This packaging is done using the Tashlik Apps (Application Builder) program. Making this comic application is done online through the website [www.apps.tashlik.org](http://www.apps.tashlik.org) which previously researchers must have an account to log into the application to then be able to make an android application.

There are four steps to creating an android application using Tashlik Apps (Application Builder), namely: (1) Pick template, choose the template you want to use. The template chosen by researchers to create a comic application is SpaceApp. (2) Edit and Configure, at this stage the finished comic sheet is inserted into an existing template by entering one by one. Besides, in this application, there is not

only a comic, but there are several other buttons such as a glimpse of comics, character recognition, attachments containing explanations of formulas, and bibliography. After all is ready to become an application, then proceed to the next stage (3) Install on the device, at this stage the design of the complete application is converted to become an android application with the extension. (4) Publish, at this stage the application with the extension .apk can be downloaded and is ready to be published in the google play store so that all Android users everywhere can download comic applications about the photoelectric effect phenomenon. The name given in this application is KEF (Photoelectric Effect Comics). There are also results from comic applications that have been developed, as in Figure 2.

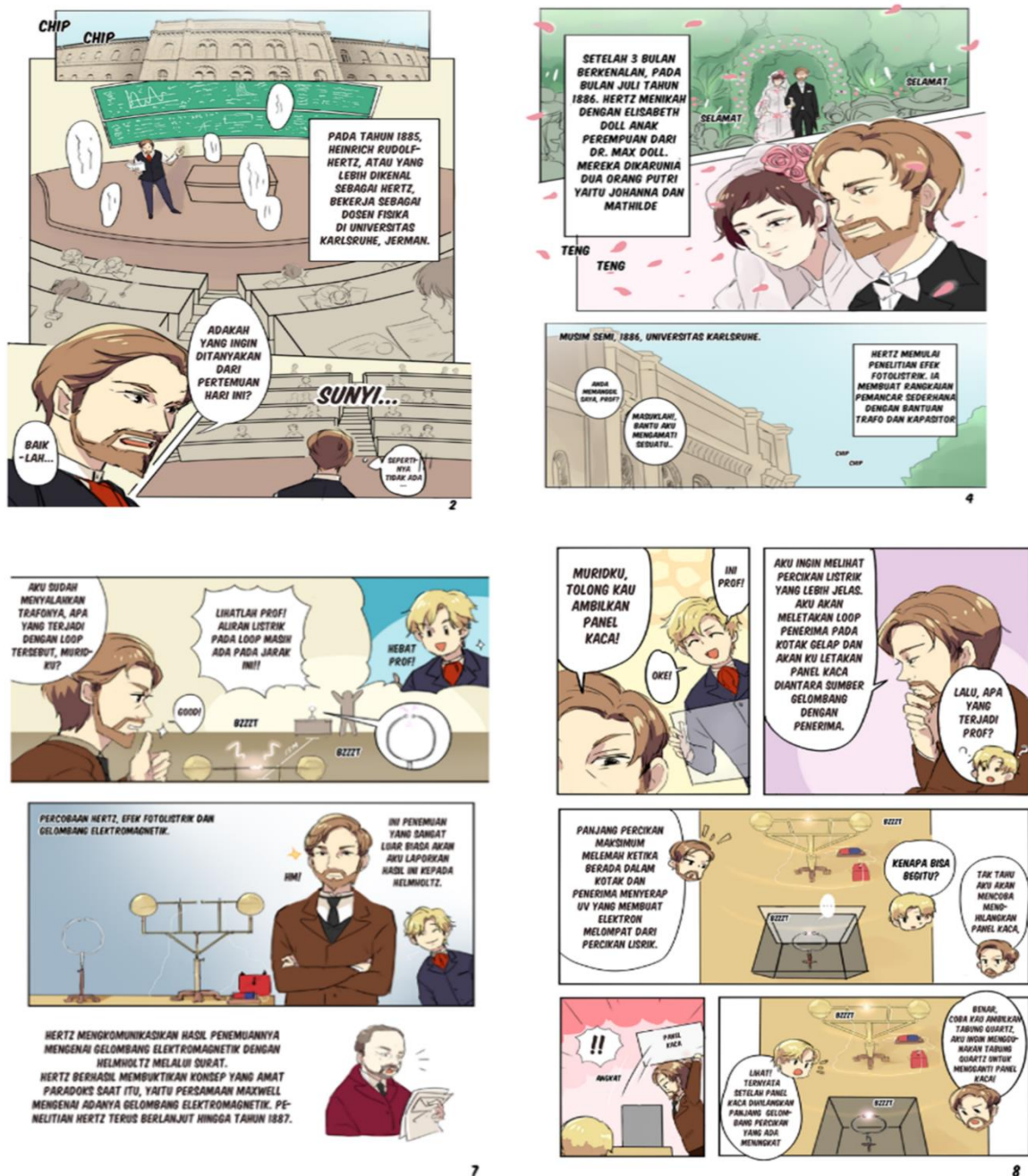
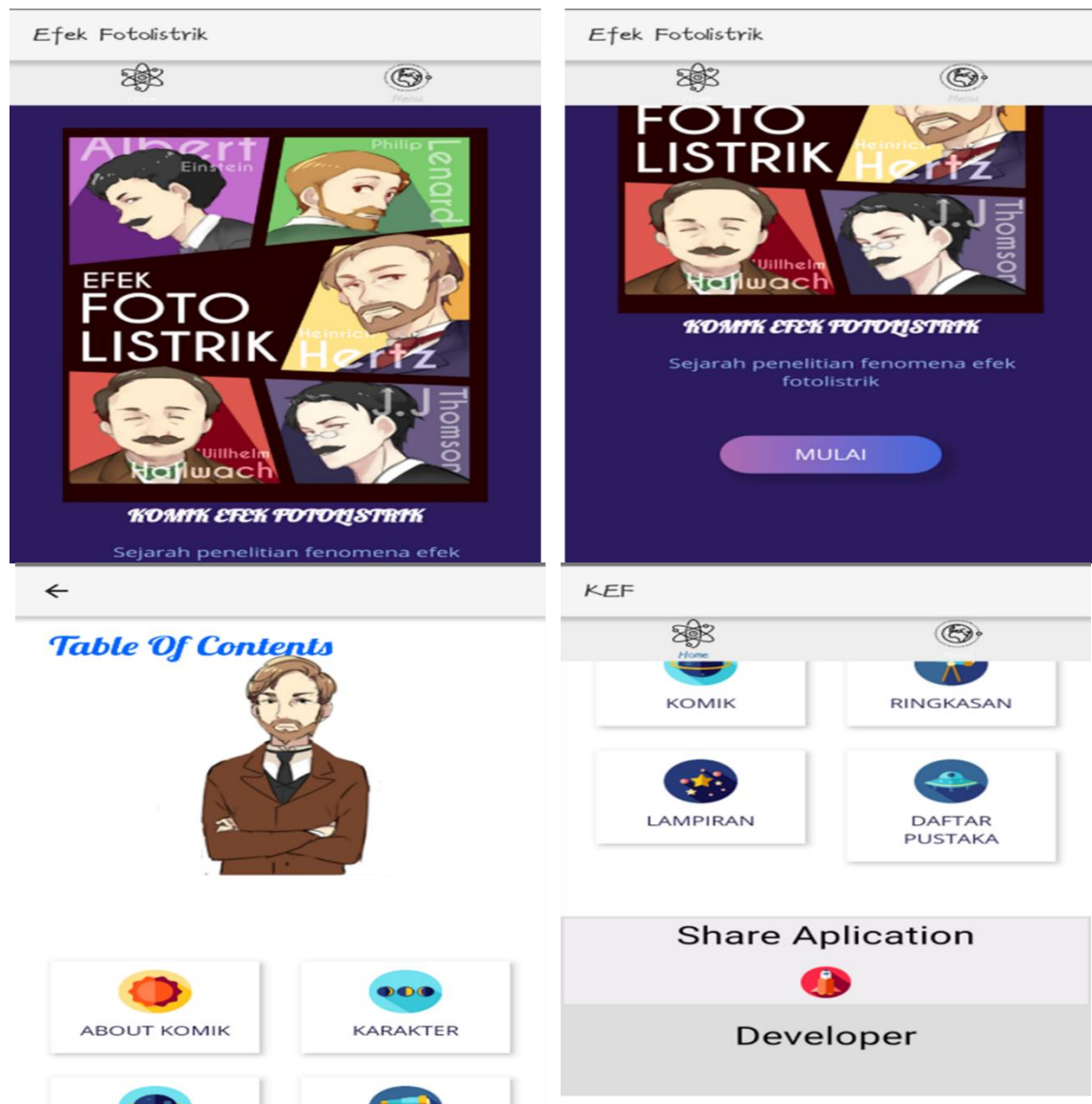


Figure 1. Drawing from the development of comics.



**Figure 2.** Comic Application Development Results for the Android Platform.

### 3.3. Formative evaluation

Assessment is given by media expert validation test sheet. This validation test sheet contains 26 questions from 3 aspects, namely the visual aspect, which consists of 10 questions, the language aspect which consists of 8 questions and the presentation aspect, which consists of 8 questions. The following are the data obtained from the validation test results. The result is shown in Table 1.

**Table 1.** Validation test results by expert.

Aspect	Percentage of achievements	Interpretation
Visualization	82%	Very good
Linguistic	80%	Very good
Presentation technique	90%	Very good
Average	84%	Very good



From the results of the validation test by media experts, the average percentage of overall aspects was obtained at 84%. Based on the interpretation of the Likert scale, these figures indicate that online comics about the photoelectric effect phenomenon for the Android system that has been developed in terms of design, presentation, and language are considered very good to be used as educational media.

**Table 2.** Improvements to comic images and text after the media expert validation test.

Evaluation	Before Revisions	After Revisions
Preposition improvements		
sentence structure		

### After Revisions

**HARTZ DAN ELEKTROSTATIS**

DARI PENELITIAN HALWAHA KEMUDIAN DITUMBUH DALAM SEBUAH PAPER YANG DELEBAR PADA TAHUNLA 20 DESEMBER, 1887 PADA TAHUN YANG SAMA DENGAN INENI PENELITIAN HERTZ, ZAM KEMUDIAN DIPUBLIKASIKAN PADA TAHUN 1888 INENI HALWAHA DALAM SEBUAH ARTIKEL.

"DALAM SEBUAH ARTIKEL YANG TERBIT BARU-BARU INI HERTZ TELAH MENJELASKAN HASIL INVESTIGASI GELOMBANG ELEKTROMAGNETIK TERHADAP KETERANGAN PANJANG MAKSIKUM DARI SEBUAH INDUKSI PERCIKAN PADA RADIASI YANG DITERIMA DARI INDUKSI LAIN PERCIKAN. HERTZ MEMBUTUKAN SAMA FENOMENA YANG DIAMIATI ADALAH SUATU TIRAKAN DARI SINAR ULTRAVIOLET. PERCOBAAN MU SULIT UNTUK DIJELASKAN DENGAN PENEMUAN YANG BIASA. SAYA TELAH BERUPAYA UNTUK MEMPEROLEHI FENOMENA TERSEKIT YANG AKAN TERJADI DALAM KONDISI YANG LEBIH SEDERHANA, UNTUK MEMBANTU PENJELASAN DARI FENOMENA DENGAN LEBIH MUDAH SAYA BERHASIL MEYELIKANI PENGARUH LAMPU LISTRIK PADA PELAT YANG DISISI SECARA ELEKTROSTATIK."

**Hertz dan Elektrostatis**

KAU SIKUN  
TITING  
PERCABANG  
BERGEMUNG  
DI  
LUPUT???

HERTZ MENONGGAR PERCOBAN HALWAHA KEMUDIAN INI MANUSIAKIN SURAT KE JAWABNYA TERUNTU BENITA ITO

RAJA  
RAJA  
RAJA

INDUSTRIE KALKULASI / INDI

AYAH BARU BARU INI ADA DUA  
MAKALAH YANG MUNCUL MENGENAI  
KAKAYA! SATU OLEH WIEDEMANN  
NYOA, DAN SATU LAGI  
DR. HALLWACH.  
MAKALAH HALLWACH JAUH  
MELAMPAUI HASIL PENELITIAN  
YANG TELAH SAYA LAKUKAN

SAYA SENANG KARENA HAL INI  
MEMBUHTUKAN SAYA TELAH  
MENABAHKAN MASYARAKAT  
INI KE SELURUH MASYARAKAT  
AKU HARUS PUAS AYAH DENGAN HASIL  
PENELITIAN KU INI DAN BUAT SAYA INI  
TELAH MENCAPI APA YANG SAYA  
INGINKAN.

HUT

GOVUP

...

SELAMAT DATANG  
DI KARLSRUHE!

TUAN  
HALLWACH  
!!

AYO  
LANJUT  
KE LAB KU

HALLWACH AKHIRNYA  
MENGUNJUNGI HERTZ DI  
KARLSRUHE

#### 4. Conclusion

Based on the research results of the online comics development about the photoelectric effect as an educational medium to support learning and formative evaluations, the comics developed success combines the online format in Android application, modifies visual designs and texts, inserting physics phenomena in historical plot.

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