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The Development of E-Comic Learning Media for Elementary School Mathematics Learning

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Abstract
This research aims to produce a mathematics learning media in e-comics for one year of learning in grade 2 elementary school. This research refers to the 4-D Development Model consisting of 4 steps, namely: (1) define, (2) design, (3) develop, and (4) disseminate. The validation test results from 2 material experts showed an average percentage of 94% and 97%, while the validation test of 2 media experts showed an average percentage of 97% and 92%. Based on these data, the E-Comic Learning Media is decent to use.

Keywords: e-comic, learning media, mathematics, 4-D Model

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INTRODUCTION

Technology is now the basis of human life amid the 4.0 Industrial Revolution or the Fourth World Industrial Revolution (Angelopoulou, Mykoniatis, & Boyapati, 2020; Bigliardi, Bottani, & Casella, 2020; Ghobakhloo, 2020). All things are infinite and unlimited due to the internet and digital technology (Alaloul, Liew, Zawawi, & Kennedy, 2019). This era has influenced many aspects of life, in industry, economics, politics, culture, and even the world of education (Antonelli et al., 2019). Education is one of the most important aspects of realizing the progress of a nation (Leonard, 2020; Sekuloska, 2014). Education, personality, thinking skills, and the character of every human can develop and produce intelligent and quality human beings. One of the characteristics of a developed nation is the quality of human resources (Solano & Rooks, 2018).

The relationship of education with the 4.0 Industrial Revolution is that education must follow the development of information and communication technologies as facilities or media that aid success in the learning process (Antonelli et al., 2019). It is in connection with the ability of educators to direct learners to be able to intelligently utilize technological sophistication (Iglesias Rodríguez, García Riaza, & Sánchez Gómez, 2017). Therefore, teachers must continually upgrade their skills and knowledge in the following technological developments (Coccia, 2020; Leonard & Wibawa, 2020). Technology usage in the learning process is expected to increase students' learning interest compared to conventional and monotonous learning processes, including mathematics learning (Bergdahl, Nouri, Fors, & Knutsson, 2020).

Mathematics is one of the main subjects in the education system in Indonesia and is one of the determinants of students' graduation to take every formal education level in

Indonesia. Daily life and the learning process never detach from mathematics (Gainsburg, 2005). However, to date, mathematics is often regarded as a harsh, frightening lesson, and not everyone can work on it (Stoica, 2015; Vourkas et al., 2014). One of the reasons that make mathematics achievement in Indonesia is very low. The results of the Trends In International Mathematics and Science Study (TIMSS) test in 2015 stated that: "Indonesian learners are only ranked 45 from 50 countries in terms of mathematical achievement". The average score of mathematical and scientific achievements in a row is 397, still significantly below the international average.

The problem of math learning achievement, the causative factor, can be sourced from students, can be sourced from teachers, tools, or the environment. Because learning will occur in various situations and environments, the factor that comes from students is often the low activeness of students in learning mathematics. At the same time, the factors that come from teachers include non-innovative learning strategies, non-variative learning methods, less maximal and less creative learning media, and tedious learning processes.

One way to make learning enjoyable and not monotonous is to utilize innovative and creative learning media. Learning media innovations can take advantage of technological developments to make the look and style of learning more attractive and prevent students from feeling saturated or bored while attending learning (Gavaldon & McGarr, 2019). The development of learning media today is quite numerous and varied. Therefore, teachers as learning facilitators must choose learning media following learning competencies and understand students' concepts. In addition, they understand the concept of students concerning the education level of the students.

Students at the elementary school level have been able to think and be creative but have not developed cognitive skills in total. One of the characters' students in elementary school age, more specifically in low grades such as grade 2 elementary school, is thinking concretely. In this stage, the child learns from the real things through their five senses, such as being seen, heard, smelt, touched, or felt (Florea & Hurjui, 2015; Warren, Cooper, & Lamb, 2006). In addition, the character of their age prefers to play or have fun (Mason & Rich, 2020). Therefore, the appropriate learning media to be applied at that age is a fascinating, easy, fun learning medium using one of the five senses and can increase students' creativity, such as comics.

As the times progress, it affects the development of comics, namely the existence of e-comic. E-comic is a digital electronic comic. Comics are a form of visual communication that has the power to convey information popularly and easily understandable (Guérin, Rigaud, Bertet, & Revel, 2017; Honarvar & Rahimi, 2011). The comic power is the collaboration between text and images that strings into a storyline. Images make stories easy to absorb, the text makes comics easy to understand, and the storyline creates the message or information to convey that will be easy to follow and remember (Kindborg & McGee, 2007). Using comics as a learning medium can increase students' learning interests without exception for math learning. Through pictures, students, especially in grade 2 elementary school, can easily understand the material and concepts of learning to solve math learning problems. Therefore, this research aims to develop e-comic learning media for elementary school mathematics learning.

METHODS

This development research uses a 4-D (Four-D model) development design model developed by Thiagarajan (1974) (Hobri, Murtikusuma, & Hermawan, 2019; Siswoyo, Mustokoweni, & Muliyati, 2020; Yuliana, Wiryawan, & Riyadi, 2018). This research used 4-D models as it is systematic and best suited to be applied in the development of learning

media in the form of e-comic. In the implementation of the research, researchers modified the model of 4-D development design according to the research needs caused by a pandemic condition factor to restrict researchers from conducting the overall research. There are 4 phases of this model, and the first phase is Define; this stage is divided into several steps of analysis*: Need analysis or front-end analysis* conducted to know the fundamental problems in the development of e-comic media. At this stage, an open interview was conducted for the classroom teacher at SDIT Nurul Iman to know the data about the state of learning and the need to develop e-comic learning media. *Next, learner analysis* is conducted by observing the characteristics of the students by taking into consideration the students' traits, abilities, and experiences, both as groups and individuals. *Next, task analysis or curriculum* is done to find information about the curriculum and syllabus used as a reference in making e-comic media. The last, *Concept analysis or material* is done to determine the contents of the material in e-comic media developed based on the information of KI and KD obtained from the curriculum analysis stage. Broadly the purpose of this stage activity is to define the terms of the teaching. Through this analysis, the objectives and constraints for teaching materials can be determined.

The second phase, Design, is divided into several parts: *Media selection* is conducted to identify learning media relevant to the material characteristics and according to the needs of students. Media is chosen to tailor student, curriculum, and material analyses. In addition, it is helpful to assist students in achieving core and expected essential competencies. *Format selection* is intended for designing learning content, learning resources, organizing, and designing e-comic content, and creating the e-comic Design, including layout design, drawings, and writing. The last, *Initial Design*, aims to design prototype materials.

The third phase is Development: *Expert appraisal*. In the development phase, researchers apply modifications to the 4-D model of development and only conduct expert appraisal activities due to a pandemic that restricts researchers from conducting limited trials on students. Expert appraisal is a technique to validate or assess the feasibility of a product design performed by experts to produce good e-comic media based on expert input. This expert validation validates the content of advanced mathematics and e-comic media. The Material and Media experts will then assess the e-comic media that has been compiled, so it can be known whether the e-comic media is worth applying. This validation is used as a material improvement to the perfection of the e-comic media developed.

The fourth phase is Disseminate: *Packaging*. This stage is a stage of product use (E-Comic Learning Media) that has been developed. This stage aims to disseminate e-comic media to be absorbed or understood by others and used (adopted) in their classrooms. The product will be disseminated and promoted to the mathematics teacher at SDIT Nurul Iman Pondok Bambu and uploaded to e-comic media as a personal blog.

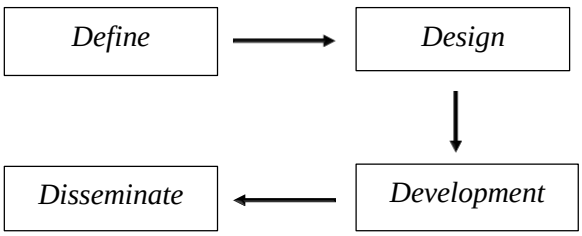

Figure 1. 4-D Model Development Design

Quantitative product quality assessment data is obtained from validation questionnaires provided to media and materials experts. Assessment based on the Likert

scale. The Likert scale measures several questions about opinions detailed on a scale of 1, 2, 3, 4, and 5 that starts from significantly less, less, reasonable, sound, and excellent. Next is converted with the formula as follows:

$$Score\ Percentage = \frac{\Sigma\ Acquisition\ Score}{\Sigma\ \text{Maximum Score}} \times 100\%$$

The scoring percentage is then measured using the score interpretation (Sugiyono, 2013).

Table 1. Interpretation Score Likert Scale of Expert Test

Score Percentage	Description
0% - 20%	Very less decent
21% - 40%	Less decent
41% - 60%	Decent enough
61% - 80%	Decent
81% - 100%	Very decent

RESULT & DISCUSSION

Result

The product that resulted from this development research is media learning in the form of e-comic or digital comics that discuss mathematics learning material in grade 2 students for one year of learning. There are also exercises and discussions to increase students' understanding of learning mathematics in this product according to the material discussed in this e-comic. With the developed media learning, e-comic is expected to help students learn mathematics and improve the spirit of learning mathematics.
The procedure used in the development of this product is adaptation and modification of the stages of research and development of the 4-D model developed by Thiagarajan (1974), namely: 1) Define, 2) Design, 3) Development, and 4) Disseminate. The development stages are described as follows:

Define

Activities at this stage are conducted to define the terms of development. In general, this definition is done to meet the needs of development. An open interview with the class teacher needs to analyze to dig into the information needed in the study. Based on the interview results obtained, helpful information for student analysis is about the characteristics of second-grade students who are very active, have a high soul play, like natural or concrete things, like colors and pictures, and are happier to play while learning. In addition, the information obtained for the curriculum analysis is the 2013 curriculum. This curriculum is used as a reference in making e-comic media. Furthermore, material analysis determines the material presented in e-comic media by identifying KI and KD in the curriculum syllabus 2013 Class 2 Elementary School Semester 1 and Semester 2-year lessons 2020/2021 based on information obtained from previous stages.

Design

At this stage, researchers process data from the result of the define phase and then start designing the media to study in the form of e-comic by making three steps: media selection, format selection, and initial design. First, media selection is determined based on

the information obtained at the define phase; the media that corresponds to the characteristics of second-grade student elementary school and can help students learn mathematics is an e-comic learning media. This media is chosen based on student's needs and to assist teachers in learning mathematics in second-grade elementary school. The application used to design e-comic media is the IbisPaint application.

Math learning media in e-comic is designed with an attractive look and easy-to-understand language. Inside, it contains elementary school grade 2 mathematics learning materials for one year of learning following the syllabus curriculum 2013. In addition, researchers use learning resources in the form of "Buku Tematik Terpadu Kurikulum 2013 Kelas 2 SD Revisi 2017" from the Ministry of Education and Culture as a reference in drafting materials on e-comic media created.

In the initial design, the first step is to design the character that will be the comic's main character. Researchers designed characters with the IbisPaint application. In determining the figure's character, the researcher adjusts to the target subject in the study of second-grade students. Therefore, the researcher decided to create the character stationery equipment as the main character. Stationery, such as pencils, books, pens, rulers, and erasers, are very familiar among students; they always use stationery daily. That way, students will easily remember the character in this e-comic. This comic has five characters: Ecil, Bu Ku, Pena, Peng, and Aris. The screenplay considers the educative side as a learning media that provides various new learning media for students. This comic tells the story of the stationery character portrayed as if it has lifelike elementary school students who live in daily life. The story depicted in this comic depicts the daily life that students experience. It helps students to understand the material more easily. The story is also sustainable from chapter 1 to chapter 8. In this comic, there are also exercises and discussions in each chapter. After making the screenplay, the next is to design the overall picture of the story. In the image creation of the entire story, researchers collect images obtained free of charge on certain websites to be used as a background on each story panel and as complementary images. After that, the researcher designed the comic using the application IbisPaint. Comics are designed by combining the background of the images that have been collected with characters created by researchers, as well as adding word balloons. Here are examples of illustration images from the merging of backgrounds, characters designed, complementary images, and the addition of word balloons.

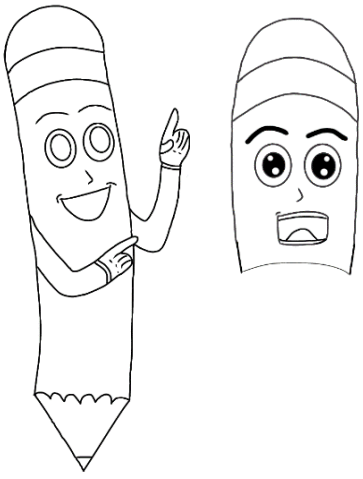

Figure 2. Character Design Ecil

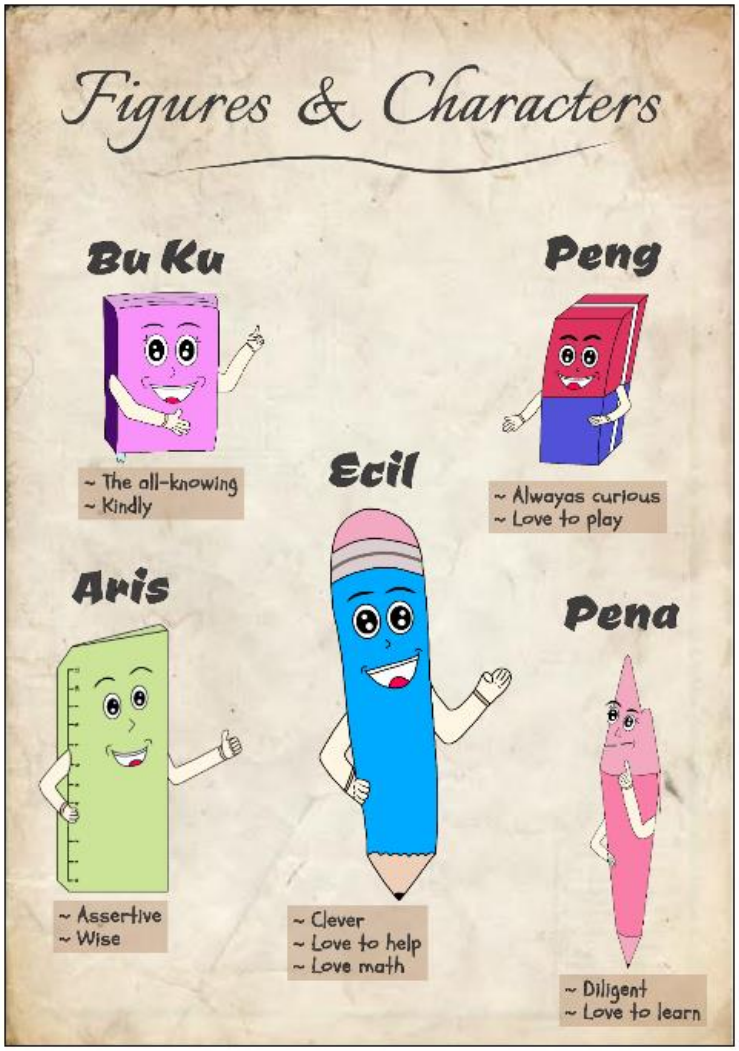

Figure 3. Figures and Characters

Development

At the development stage, modifications to the 4-D development model applied by researchers are only conducting expert appraisal activities due to the pandemic that restricts researchers from conducting development tests on students. The expert appraisal is a technique to validate or assess the feasibility of a product design performed by experts. The suggestions given by the experts are used as a reference for improving the materials and learning design that has been compiled.

Table 2. Material Expert Validation Test Results

Aspect Assessment	Percentage		Average	Interpretation
	Material Expert I	Material Expert II		
Curriculum	93%	93%	93%	Very decent
Linguistic	95%	100%	98%	Very decent
Average	94%	97%	[redacted]	Very decent

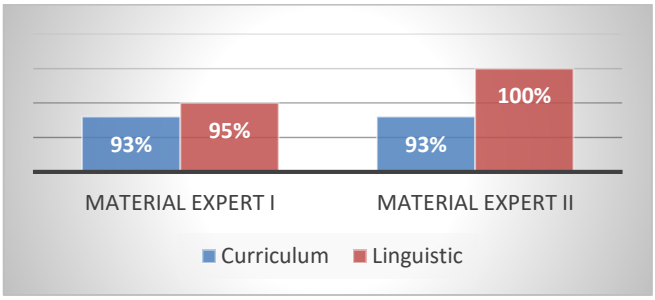

Figure 4. Material Expert Validation Test Results Diagram

Based on the expert validation test result, the assessment results obtained from a material expert I for the curriculum aspect of 93% and the linguistic aspect of 97%, then averaged 94%. At the same time, the assessment from the material expert II for the curriculum aspect of 93% and the linguistic aspect of 100% then averaged 97%. Based on the data, if interpreted on the Likert scale, it can be concluded that the product is developed very decent to use in terms of material. However, there are some suggestions submitted by both material experts. For example, researchers should improve the advice material experts provided to fix some of the less clear images and improve the word balloons that make dialogue drop. In contrast, the advice given by material expert II is that the product that is developed can be accessed offline to facilitate the learning process without a disrupted Internet connection. Therefore, responding to material expert II researcher advice makes software applications and PDF format on the developed product so that the teacher can access it offline.

Table 3. Media Expert Validation Test Results

No.	Aspect Assessment	Percentage		Average	Interpretation
		Media Expert I	Media Expert II		
1	Display Eligibility	94%	83%	89%	Very decent
2	Content Eligibility	100%	100%	100%	Very decent
	Average	97%	92%		Very decent

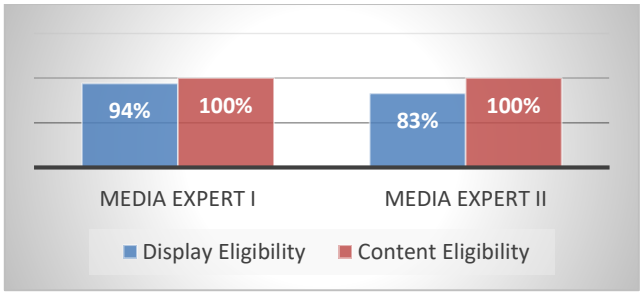

Figure 5. Media Expert Validation Test Results Diagram

Based on the media experts' validation test result, the assessment result obtained from the media expert I for the display eligibility aspect of 94% and the content eligibility aspect of 100%, then averaged 97%. At the same time, the assessment result from the media expert II for the display eligibility aspect of 83% and for the content eligibility aspect of 100%,

then averaged 92%. Based on the data, if interpreted on the Likert scale, it can be concluded that the E-Comic Learning Media products are very decent to be used. However, there are some suggestions given by the media experts. The suggestion of improvement provided by media expert I was to improve writing on the exercise of the problem to make it look more transparent and easier to read, while the advice given by media expert II is the spirit to continue to be creative.

Dissemination

This stage is done so that others can utilize the product. Packaging e-comic learning media is done by uploading e-comic into a personal blog arezvera95.blogspot.com. In addition, following the advice of material experts and development experts, the researcher also makes the product in the form of software applications that can be downloaded through the blog and PDF format that can be printed. The product will be disseminated and promoted to the mathematics teacher at SDIT Nurul Iman Pondok Bambu. The E-Comic Learning Media is disseminated to be absorbed or understood by others and used (adopted) in their classrooms.

Discussion

The final product of this development study is E-Comic Learning Media for mathematics learning which includes material for one year of study in second-grade Elementary School. This Media was developed to meet the learning needs of students according to the results of interviews that have been done with class teachers in SDIT Nurul Iman Pondok Bambu, East Jakarta. The interview results show that second-grade students have very active characters, love to play, like tangible things, and love to draw, but lack understanding. Furthermore, very active student characters show that students do not like boring learning, so teachers should have a media alternative that can attract students. Therefore, e-comic learning media is developed to help teachers overcome learning problems, attract students' attention, and make students happy and passionate about learning mathematics.

Researchers have successfully developed e-comic learning media that has been validated by experts with outstanding results and deserves to be used. E-Comic Learning Media is a learning media in the form of digital comics that have an educational element and provide a variety of new learning media to the students. Along with technology development, researchers develop e-comic learning media that can be accessed through the internet. E-comic is designed with exciting colors, and there are comic figures familiar to students and contain a storyline that depicts daily life so that students can easily understand the material. In addition, exercises and discussions in each chapter can train students to evaluate each material studied. The application used to design this e-comic is IbisPaint. There is quite a lot of similar research in developing learning media in the form of e-comic (Mustikasari, Priscylio, Hartati, & Sopandi, 2020; Nikmah, Haroky, Jumadi, Wilujeng, & Kuswanto, 2019; Rohaizati, Mailizar, & Hajidin, 2020; Taufiq, 2020). However, few are researching for math lessons Elementary School (Hidayah & Fathimatuzzahra, 2019; Hobri, Murtikusuma, & Hermawan, 2019; Yulian, 2018). Unfortunately, of the many similar research, no one uses the IbisPaint application. In addition, nothing contains second-grade elementary school material for one year of learning.

Comics generally form new characters created by the comic itself, as in previous studies (Hobri et al., 2019; Siswoyo, Mustokoweni, & Muliyati, 2020). However, in this development study, comic characters in stationery are depicted as having a life like

elementary school children. Researchers use this character because stationery is a familiar item found by the target students in this study. Almost every day, student schools will use stationery to be more easily remembered by the characters in the comic. In addition, the name of the character is also derived from the name of the stationery, making it easy to pronounce and remember students, such as the leading character name Ecil taken from the word "pencil." Picture 6 shows a difference in comic characters in this study with previous research.

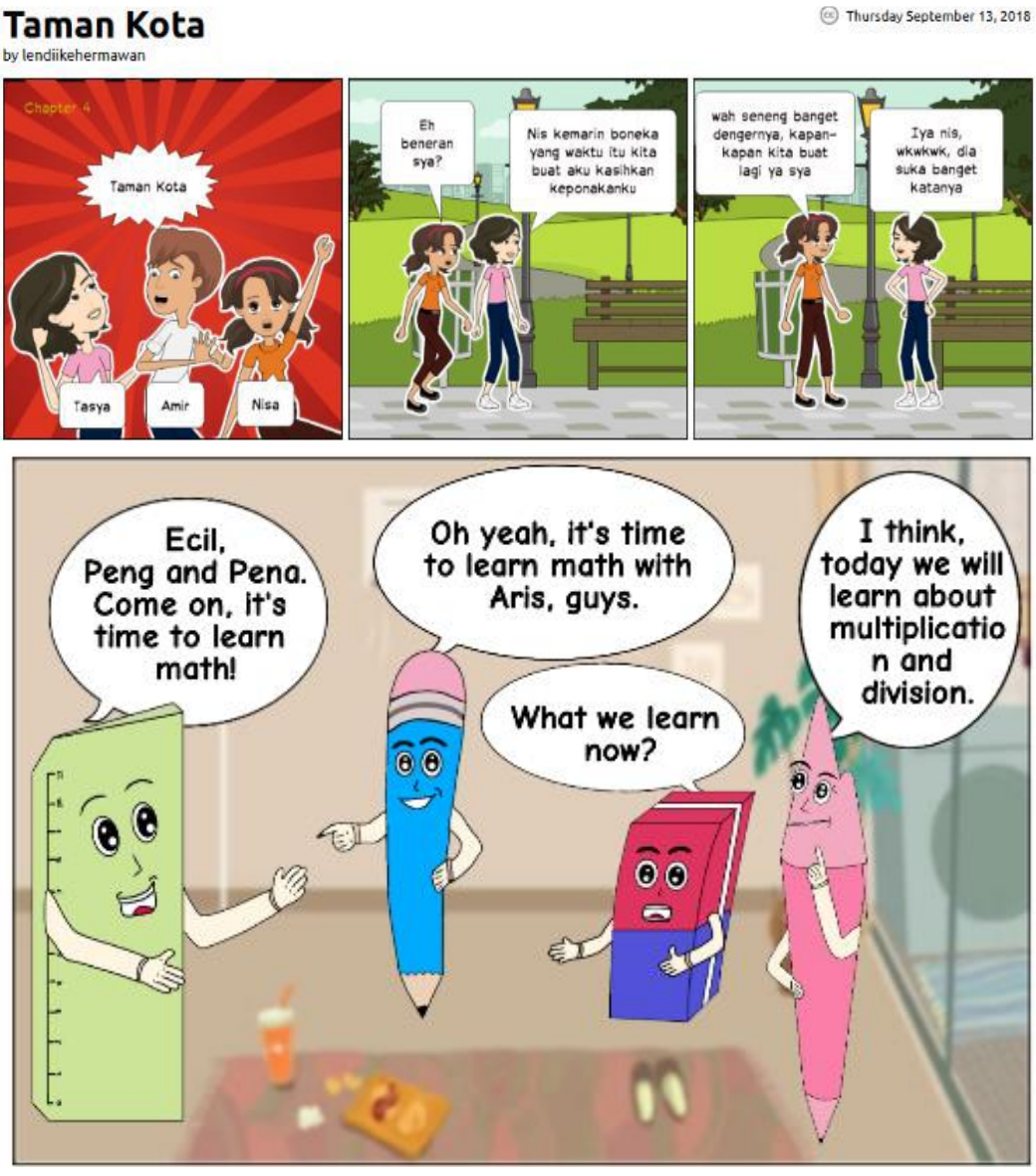

Figure 6. Comic character differences in previous research (Hobri et al., 2019)

The material presented in this e-comic learning media follows KI and KD contained in the curriculum syllabus 2013 and sourced from "Buku Tematik Terpadu Kurikulum 2013 Kelas 2 SD Revisi 2017". It has been tested for feasibility by material experts with the results are very worthy of use. Both material experts responded

positively to the e-comic learning media developed and gave constructive advice. Following the advice given by the material experts, researchers make e-comic learning media in PDF and software applications so they can be used offline without worrying about an internet connection. The media of e-comic learning is also validated by the media experts with very decent results to be used, and the response given by both media experts is also very positive. At the development stage, researchers do not conduct limited trials on students due to several conditions:

1. Pandemic conditions that make students still learn online to restrict the movement of researchers in conducting trials.
2. Students targeted in this research is the second-grade elementary school that has not been familiar with how to use Google Form without adult assistance.
3. Without explanation and help from researchers directly, second-grade students are challenged to understand the questions posed on the poll.

Based on the condition to avoid things that can doubt the outcome of the validity, the researcher does not conduct a limited trial of the students. The advantages of the development of e-comic media, among others, can eliminate the saturation of students in learning (Rahayu & Kuswanto, 2020), can improve student mathematics communication (Yulian, 2018), can map students' motivation (Nikmah et al., 2019), and can improve students' independence in learning (Taufiq, 2020). At the end of the research process, researchers disseminate the revised e-comic learning media to SDIT Nurul Iman Pondok Bambu and share it through a personal blog arezvera95.blogspot.com. Users can access e-comic learning media online and offline through the blog. This e-comic learning media spread can be applied and utilized in the learning process. Figure 7 is a view of the blog that contains the e-comic learning media, picture 8 displays PDF files that can be downloaded through the blog, and picture 9 displays e-comic learning media applications that can be opened on an Android smartphone.

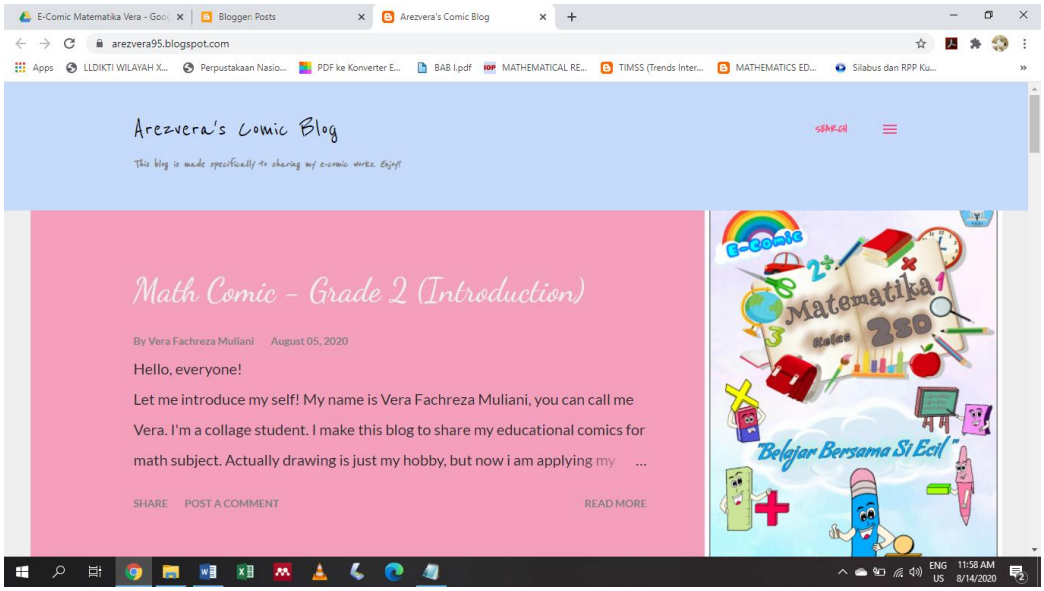

Figure 7. Blog View

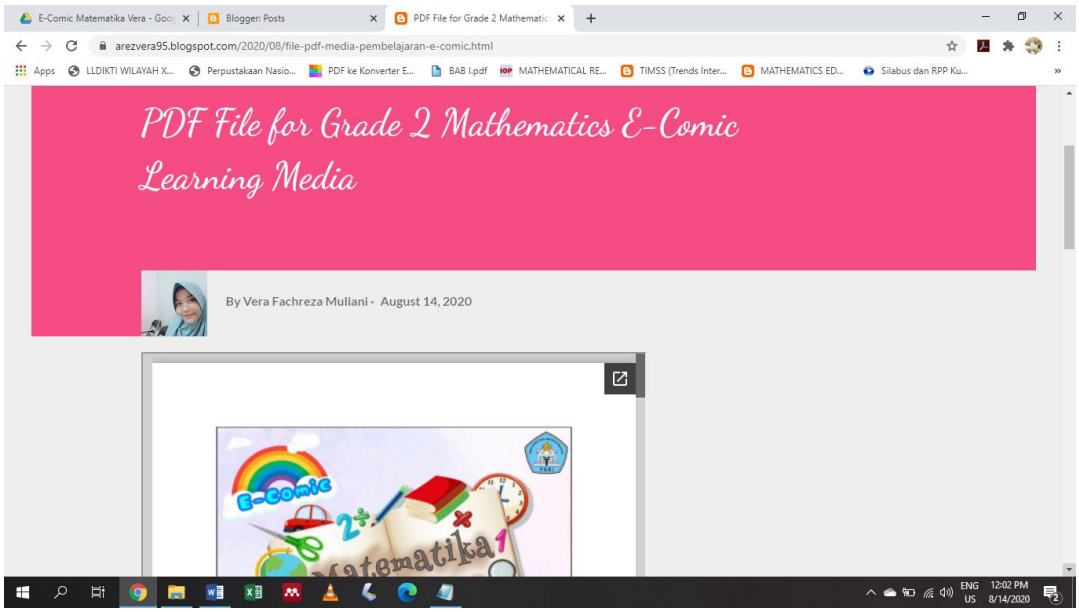

Figure 8. PDF File View

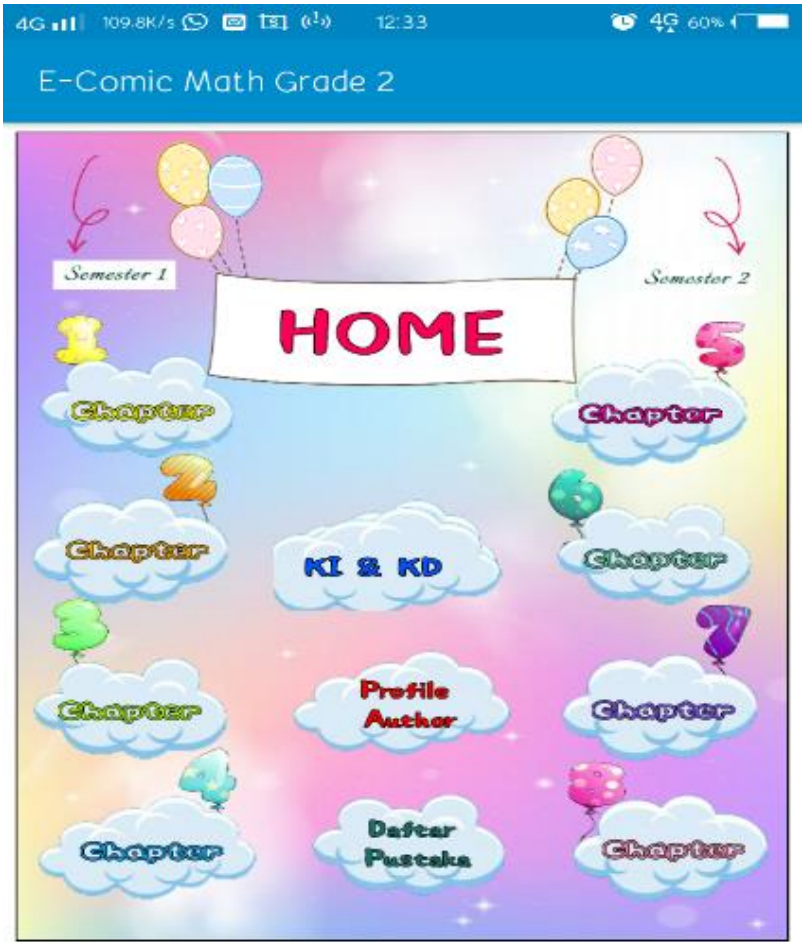

Figure 9. E-Comic Learning Media App View

CONCLUSION

The Development of E-Comic Learning Media for Elementary School Mathematics Learning that adapted and modified from the development procedure by Thiagarajan (1974), which includes 4 phases of development, namely: 1) Define, including need analysis, student analysis, curriculum analysis, material analysis, 2) Design, including media selection, format selection, initial design, 3) Development, including the assessment by 2 Material Expert which each obtained on average of 94% and 97%, and 2 Media Experts each obtained an average of 97% and 92% so it can be concluded that the e-Comic learning media is appropriate to apply in Grade 2 Elementary School Mathematics Learning, 4) Disseminate includes dissemination to SDIT Nurul Iman and dissemination via the Internet.

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