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## The Development of Learning Media “*Petuah Kimia*” (A Digital Chemistry Bond Material)

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### Abstract

The Indonesian children's literacy is still relatively low, and it has become a severe problem that the government, teachers, parents, and librarians should face. The data shows that only 10% of Indonesian children like to read a book, while most chemistry material is written in textbooks. This study aims to produce digital comics with chemical bonding material, determine comics' feasibility, and respond to readers. The research method develops the Borg and Gall model with seven stages of development without compromising the essence of the model. Meanwhile, data collection techniques are interviews, validation, and questionnaires using a Likert scale. The media and material validator has validated the product developed in this study. As a result, the media aspect has an overall score of 48 or 100%; the score belongs to the very decent criteria. The material aspect has got a score of 26 or 93% from the basic chemistry lecturers; Also, the chemistry teachers give 100%. In addition, the digital comic readers have an extensive test. Conversely, 48 respondents have been assessed with an overall score of 2753 or 90%. Hence, this percentage value relates to the very feasible category. Thus, the characteristics of this digital comic have fulfilled the material, media, language, and visual aspects; since it is included in the worthy category as an independent learning medium without replacing the role of educators.

Keywords: borg and gall, chemical association, digital comics, learning media

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### 1. Introduction

Learning is a process that regulates and organizes the environment around students to grow and encourage students to carry out the learning process. The learning process is a procedure between educators and students to achieve learning objectives using learning resources. In addition, the learning process can occur anywhere, whether at school or campus, at home, and in the living environment; besides, the learning process can be done anytime without any attachments or time constraints (Azhar, 2013). Also, the learning process in human life will always exist from birth to death. Moreover, the evidence of the learning process is a change in attitudes, skills,

or knowledge in a person (Pane & Dasopang, 2017).

On the other hand, natural science is one part of the science that needs to be studied, where this science studies natural life related to human activities in their daily lives (Rediarta et al., 2014). One branch of natural science is chemistry; this science studies matter and change. Besides, elements and compounds are substances involved in chemical changes (Chang, 2005). Materials from learning chemistry include principles, laws, facts, and concepts. According to Uliyandari et al. (2014), explains that some students consider chemistry as a complex subject. This subject is based on the difficulty in understanding chemical concepts. Therefore, the students' difficulty

understanding chemical concepts is due to the abstract concept of chemistry.

One example of material in abstract chemistry lessons is chemical bonds. Chemical bonding materials are grouped into four sub-materials: ionic, covalent, metallic, and intermolecular (Vrabec & Prokša, 2016). Therefore, this material explains how the atoms in a compound form bonds with each other or with other atoms that are abstract. Furthermore, students lose interest in learning and understanding the concepts of this material.

In science, especially chemistry, students are required to read so that the learning objectives can be adequately achieved. According to Tiemensma (2009), reading is a component in the 21st century to survive the global economic competition. Therefore, the teachers, parents, and librarians face a considerable challenge in creating this reading habit. Meanwhile, the Indonesian' literacy culture is low, and it is estimated that only 10% of Indonesian children belong to the reading group (Sugiharti, 1997). Thus, this case presents because some Indonesian children have just reached the level of liking to see or hear, not yet reaching the hobby of reading (Sugihartati, 2018).

In addition, reading is a process of interaction between language and thought (Trianto, 2009). Most science, especially chemistry, is contained in written form or textbooks, which are the dominant instructional media in learning activities (Ulumudin et al., 2017). Moreover, the complexity and abstraction of the material in chemistry make students less interested in learning chemistry (Gabel, 1999). Meantime, students will get interest in reading when they find something interesting and give its meaning (Hurlock, 1980). On the other hand, Sugihartati (2018) explains that one type of reading that is in demand by urban youth is popular fiction novels and graphic comics; so, the use of learning media that vary writing with pictures can be a solution to grow the attractiveness of students in reading activities. In other words, media can engage students' interest to learn some materials.

Media is a tool for channeling information that connects the source of information with the recipient. In this sense, learning media is defined as a communication facility that can clarify the meaning of communicators and communicants (Nur'aini, 2005). In general, the media is a tool in the learning process. Learning aids must support students to learn quickly and efficiently; even if needed, students can learn independently (Nurrita, 2018). On the other side, good learning is active learning, so that learning media has advantages, and it can increase student participation (Sardiman, 2010). The active involvement of students will encourage the formation of students' learning motivation. High learning motivation will have a very positive effect on the cognitive activity of students, so it is hoped that student learning outcomes will be even better.

Furthermore, a Learning media development by varying the writing into the form of color images and using a daily life story approach is one way to convey learning material excitingly (Rahmawati et al., 2017). This development can also be collaborated by utilizing the development of information and communication technology supported by internet facilities that make it easier for people to interact and exchange information and messages. Moreover, this evaluation can make it easier for students to access and understand chemistry concepts, especially chemical bonding material.

The development of the media is in the form of digital comics. Webtoons or webcomics are comics that are distributed over the internet. Masdiono (2014) explains that comics are a form of a cartoon that plays a story using characters that aim to entertain the reader. Comics have a unique attraction for readers, which will entertain readers with humor that spurs them to think creatively and not boringly so that they can be developed in such a way as a learning medium that does not escape evaluation and supervision (Hadi & Dwijananti, 2015).

On the other hand, conventional comics entered Indonesia in 1931; the comics were published in the Sin Po newspaper, a

newspaper originating from China. Meanwhile, this comic had published in Malay with the title "Put On" (Bonneff, 1998). In 2010, conventional comics began to be abandoned and changed to digital comics. This development of comics can be seen in the number of digital comics created by the nation's children on social media platforms. Furthermore, digital comic reading applications such as LINE Webtoon, Manga Toon, Comic Rack Free, and other free comic reading applications that can be accessed via Android appeared in 2014. LINE Webtoon is a digital comic platform that provides accessibility and convenience for readers and opportunities for creators to work. In addition, Indonesia became the country with the most digital comic readers compared to other countries, with 6 million active readers (Anggraeni et al., 2020).

The development of comics media as learning media can also erase the bad image attached to comics. According to Locke (2005), comics are often underestimated as a medium and an art form. In the Anglo-Saxon world, comics are not part of culture, art, or literature. This problem has become the popular of comics, not because they are noble and have the strangest fantasy genre by involving crazy, absurd characters that are only suitable for children and adults who are developmentally disabled (Locke, 2005). In addition, several studies found that young people enjoy reading comics and animation, and these media offer scientific views and stereotypes that deviate from scientists. However, not a few fictional comics contain accurate and factual references to scientific ideas. For example, the Donald Duck comics and Marvel Classic Comics contain various principles, processes, and chemical equations, which are valid. Although its effectiveness as a medium is not known how much success, comic media can help students remember concepts (Tatalovic, 2009).

Therefore, this research uses comics to make fun learning tools. Besides, comics are an entertainment media that can engage students' interest in learning chemistry. Tatalovic (2009) said that comics are a popular art form, especially among children and adults; thus, comics can provide potential media for

science education and communication. In other words, comics can make students think about science with a different approach, where this media can introduce scientific problems visually entertainingly with image appeal (Di Raddo, 2006). In this way, chemistry becomes more interesting than memorizing, and students can take exams successfully and express new ideas in problem-solving through the knowledge gained (Arroio, 2011). Based on these problems, the learning media *Petuah Kimia* (digital comic material on chemical bonds) was developed, which can be used by all groups.

## 2. Research Method

This development is carried out from June 3, 2021, to October 29, 2021. The research method used is the research and development (RnD) method with the Borg and Gall development model. The Borg and Gall development model consists of ten stages of development: Research and Information Collecting, Planning, Develop Preliminary Form of Product, Preliminary Field Testing, Main Product Revision, Main Field Testing, Operational Product Revision, Operational Field Testing, Final Product Revision, and Dissemination and Implementation. Besides, the researchers only took seven stages to simplify and shorten the product design. In addition, the researchers also adjust the process to development needs. Therefore, the development begins with three design development schemes: (1) The product development, is a conversion of story scripts into illustrated stories, and it consists of: (a) Storyboard, the researchers were designing a systematic outline of comic book illustrations for story panels; (b) Penciller/Inker, the illustrations contained in the storyboard are made in detail; (c) Colorist and Screen, tone giving color and background attracts attention and creates an aesthetic impression for comic readers; (d) Letterer, giving balloons and dialogues; (e) Designing a comic outline, starting from the main menu, learning objectives and indicators, character introduction, materials, and bibliography; (f) Layouting, compiling and arranging images; (g) Publication, publishing comics into the

selected application; in this case, the author uses the Webtoon application. (2) Validation Of the Expert Team. (3) Schematic Design Improvement.

Data analysis techniques are used in the form of qualitative and quantitative. Qualitative was used to manage data in the form of comments and suggestions from validators listed in the validation sheet, while quantitative was used to manage Likert scale percentage data into a measurement scale. The data is stated in a statement accompanied by four responses that determine the standard level of learning media. Meanwhile, the data collection methods in this study consisted of: (1) Interviews, interviews were conducted in unstructured or open interviews. The instrument is used in the form of interviews to determine the outline of the problem. It aims to determine the characteristics and difficulties of students in learning chemistry as an analysis of the needs of chemistry learning media. Furthermore, this way was used to identify the students' cognitive, psychomotor, and affective characteristics. (2) Questionnaire, This research used a questionnaire instrument with a Likert scale. Besides, the form of a checklist (✓) belonged to a scale of 4. The purpose of using a questionnaire: (a) Questionnaire for media and material validators, testing the feasibility of the product in terms of material and media, (b) Questionnaire of readers to find out the response or responses of readers in the form of comments and product suggestions developed as improvement materials, as well as to test the practicality of the product. It is intended that the learning media developed are genuinely valid and follow the needs of students. Although the learning media developed was declared feasible by the validator, if the student response was negative, it was necessary to make improvements. (3) Documentation, is used to add information/evidence to this study. In this study, the scale measurement level with neutral answers was not used so that respondents could determine their opinions and attitudes regarding the statements that the researchers had proposed in the questionnaire/questionnaire. This way is used to reduce errors in data management using the Likert scale

method, namely the medium bias or trend error.

The percentage of assessment scores from experts/validators is calculated using the formula below:

$$\%X_{in} = \frac{\sum s}{s \text{ maks}} \times 100\%$$

Description:

$\%X_{in}$  = Percentage of score answers to the i-question research instrument.

$\sum s$  = Total answer scores

s maks = Maximum Score

(Sudjana, 2005).

The calculation of the average percentage of product assessment results is converted into an assessment statement to see the quality and benefits of the product sourced from the assessment of digital comic readers. The assessment of the learning media product of *Petuah Kimia* (chemical bond digital comics) is completed when a score is obtained, which indicates that the product has occupied the eligibility rules with the level of the technical quality of the media and the suitability of the learning media in the very feasible or appropriate category.

### 3. Result and Discussion

The research and development stages of the Borg and Gall model carried out in this study include the preliminary study, planning, schema design, limited-scale testing, product improvement, broad-scale testing, and product improvement improvements that have been tested. From the results of the research at each stage, the following results are obtained:

#### 3.1. Previous Studies

In the preliminary study stage (Research and Information Collection), there are two research stages: (a) Literature study to collect information about problems that arise in the chemistry learning process. The data obtained becomes a guide for researchers to analyze the needs of learning activities and develop the concept of learning media, and (b) Field observations were conducted on students of the 2019/2020 Chemistry Education study

program at UIN Walisongo Semarang. This field study was conducted on April 7, 2021, by distributing questionnaires using google forms and interviews. The results obtained from this observation are discovering several problems in understanding chemical materials, especially in chemical bonding materials. The difficulty of this case is related to understanding abstract concepts and material in textbooks with minimal illustrations. This problem causes students to be lazy to read and study chemical bonding material.

Based on this preliminary study, it is necessary to develop learning media by taking into account the VISUALS principle: Visible (easy to see), Interesting (attractive), Simple (easy to use), Useful (proper), Accurate (precise and accountable), Legitimate (valid and logical), and Structured (organize) (Nurseto, 2011). These principles have inspired researchers to offer digital comics learning media that can be an alternative media in an increasingly advanced era in terms of technology and knowledge, especially in using websites and internet networks in the independent learning process at home. Meantime, digital comic learning media is also helpful in a growing interest in reading.

### 3.2. Planning

This development is carried out from June 3, 2021, to October 29, 2021, at Rp. 129,000,-. This fee is used to subscribe to the Ibis PaintX version 9.2.1 digital illustration application for three months with a monthly payment of IDR 43,000. Therefore, Researchers also combine all

information and supporting media to formulate steps for media development, such as compiling material based on indicators and learning objectives into a story, determining characters and their characteristics, and determining illustrations of a chemical compound.

### 3.3. The First Development

The initial development stage (Develop Preliminary of Product) was developed by developing a comic design, starting with making a storyboard, penciller/inker, colorist and screen tone, lettere, designing a comic outline, layout, and publishing. The comics that have been compiled are then validated by one media expert validator, namely a lecturer in art and architecture, an illustrator and a comic artist, and two material experts, consisting of a primary chemistry lecturer and a chemistry teacher.

The feasibility of the digital comic *Petuah Kimia* was developed by Arsyad (2015), but the researcher developed the indicator based on the needs of the researcher. The results of the expert validation assessment can be seen in Table 1.

Based on Table 1, the first validation resulted in an average score of 86%; the improvements were made based on the suggestions. Besides, the second validation resulted in an average score of 98%. The comments and suggestions given by the validator are listed in Table 2.

**Tabel 1. Digital Comics Validation Results of *Petuah Kimia***

Respondent	Validation I		Validation II	
	Percentage	Description	Percentage	Description
Media Expert Validator	83%	Very Proper	100%	Very Proper
Material Expert Validator 1 (Basic Chemistry Lecturer)	75%	Proper	93%	Very Proper
Material Expert Validator 2 (Chemistry Teacher)	100%	Very Proper	100%	Very Proper
Average	86%	Very Proper	98%	Very Proper

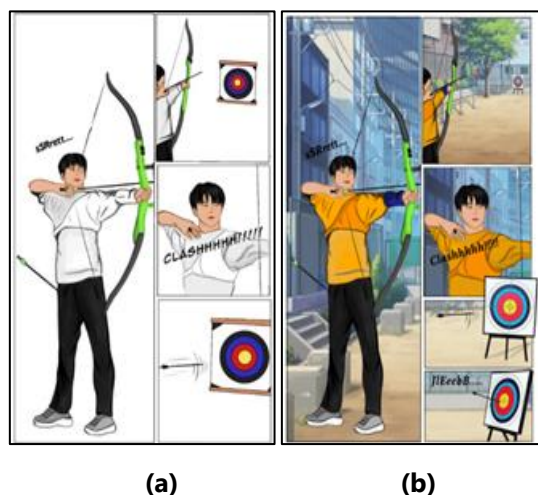
**Table 2. Expert Validator Comments and Suggestions**

No.	Comments and Suggestions
1.	The cover and title are too complex, do not describe the contents of the comic story, and the illustrations are not realistic.
2.	The color selection is too pale and doesn't include descriptions of the characters.
3.	The setting of place and time have not been clearly described, and the use of fonts are too diverse; there is a lack of narration to reinforce the storyline.
4.	Learning objectives and indicators have not been included in the story.
5.	The material concept is long-winded; it can lead to multiple meanings and lacks detail in explaining a material.

Based on Table 2, after receiving comments and suggestions from the expert validators, the researchers changed the mistake based on the directions as follows:



**Figure 1. (a) Front Cover Before Revision; (b) Front Cover After Revision.**



**Figure 2. Changes in Graphic Aspect: (a) Before Revision (b) After Revision.**



(a)



(b)

**Figure 3. Changes in Material Aspects: (a) Before Revision (b) After Revision.**

### 3.4. Limited-Scale Product Testing

Product testing on a limited scale (Preliminary Field Testing) was carried out on chemistry education students in 2019/2020, with 22 students to find out the practicality of digital comic products as learning media. The results of the practicality test by students have an average percentage of 91%, with a very decent category.

Practicality tests were also conducted on educators (chemistry teachers); there were two chemistry teachers from two different schools providing practicality test assessments for this



chemistry comic learning media product. The results of the practicality test by educators (chemistry teachers) obtained an assessment percentage of 92% with a very decent category. In addition, the educators give suggestions to researchers to make improvements. The aspect suggestion is the systematicity of the material presented. Furthermore, the educators suggest that the preparation of the Lewis structure material should be sequentially starting from a simple Lewis structure, such as the basic Lewis structure first, then developed and given an example of the Lewis bond structure, clarifying and adding detailed octet exception material.

### 3.5. Limited Revision of Initial Test Results (Main Product Revision)

The limited test results show that the product is suitable to use as a learning medium. The students provide some comments and suggestions, such as the need to convert comics into pdf or print form so that they can be read offline, provide more natural colors, and pay attention to word errors or typos.

### 3.6. An Extensive Product Testing

The extensive product testing (Main Field Testing) was carried out for readers of the *Petuah Kimia* comic, and the researchers included a google form link in the comments column so that readers could participate in the assessment of learning media products. The assessment includes: (a) media aspects, such as ease of use, instructions for use, usefulness, and product attractiveness. (b) Linguistic aspects include ease of language, the accuracy of type and size of letters, and storyline. Moreover, (c) Material Aspects: the material is delivered coherently, the media helps readers understand the material, increases reading interest, and helps independent learning. The assessment is presented in the form of a checklist (✓) with a rating scale of 4.

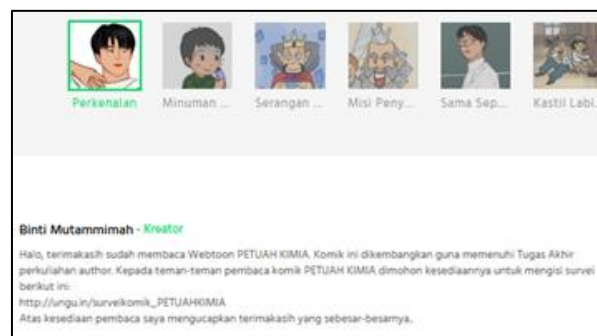


Figure 4. *Petuah Kimia* Comic Reader Rating Link

On January 14, 2022, comic books were viewed 1,785 times with a rate of 10 and 47 followers; Meanwhile, the readers come from students, chemistry and chemistry education students, alumni and chemistry teachers, and the general public. As a result, 48 readers gave their assessments through a google form questionnaire. This questionnaire obtained a score of 2753 out of 3072 and the maximum number of assessments. This value has a percentage of 90%. If converted into an assessment statement to see the quality and benefits of the product, this percentage value can be interpreted as a very viable learning media product.



Figure 5. *Petuah Kimia* Reader Statistics (Digital Comics on Chemical Bonds)

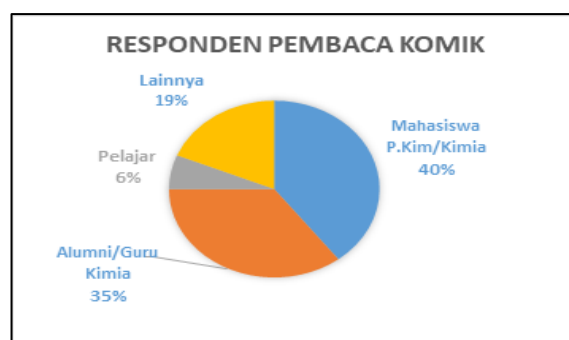


Figure 6. The Graph of Respondents of The Digital Comic Readers Chemical Bonds

The trial results of research and development of the digital comics on chemical bonds indicate that the product is very suitable as a learning medium that provides visualization of chemical bonding material to students without replacing the role of educators. On the other hand, the strength of this media lies in narration, images, and the use of complementary colors, where comic art becomes a medium to convey complex information more straightforwardly and enjoyably. This finding is in line with Lova et al. research (2013), comic media featuring illustrations attract attention, and using complex colors can build students' motivation to study harder. Furthermore, comics as learning media can also increase students' reading motivation. In addition, the comic illustrations create a sense of pleasure, so the students' interest in reading the learning material increased by 90% (Herawati et al., 2014).

Added by Malviya & Verma (2010), digital reading has improved students' reading interest because of the development of technology and the maturation of the world of education into the digital era. Moreover, this digital reading trend also occurs in comic reading activities. Furthermore, developing comic learning media into digital form makes learning media more practical. In addition, the researcher has evidence that is found by doing a researcher's practicality test of readers obtained a score of 2753 out of 3072 with a percentage of 90%. Besides, Purnama et al. (2015) stated that comics media in digital form, either through applications or websites, are more preferred than comic media in print. Even less, digital comics are more practical and easier to carry anywhere.

### **3.7. Product Evaluation of Extensive Testing**

The last stage of this digital comic learning media development is revising the results of the comprehensive practicality test (Operational Product Revision). Meanwhile, the readers come from students, chemistry

students, teachers, and the general public. However, the researcher also got several suggestions, such as not showing the uniqueness or identity of the archipelago, using good Indonesian language to make it easier for readers from eastern Indonesia to enjoy this comic, as well as extending comic episodes, or making a sequel to the comic that was developed. These suggestions are input for researchers to develop better chemistry comic-based learning media in the future.

## **4. Conclusion**

The learning media of *Petuah Kimia* (digital comic material on chemical bonds) is produced and published through the webtoon digital comic platform with the scientific fantasy genre. This comic was developed through the Borg and Gall model, consisting of seven stages: Research and Information Collecting, Planning, Develop Preliminary Form of the Product, Preliminary Field Testing, Main Product Revision, Main Field Testing, and Operational Product Revision. In addition, the material on chemical bonds includes the types of chemical bonds, such as ionic, covalent, and metallic bonds, as well as the octet and duplet rules, Lewis structures, and formal charges. This comic is categorized as feasible to be a learning media based on assessing media and material expert validators. This learning media has a percentage of the feasibility value of 100% in the media aspect and 93% in the material aspect. Meanwhile, the learning media for digital comics on chemical bonds was developed online to disseminate learning media products more open and sustainable. Besides, this system is supported by the comment column provided by the Webtoon application for each story episode; Also, the readers can provide input to creators regarding published comics.



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