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The Development of Acid-Base Electronic Chemistry Comic Learning Media for High School Students

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ABSTRACT

The Acid-base electronic chemistry comic learning media for high school students was developed to make it easier for students to learn chemistry subject, especially Acid-base material. This study aimed to 1) develop Acid-base electronic chemistry comic learning media for high school students, 2) find out the level of validity of the Acid-base electronic chemistry comic learning media for high school students, and 3) find out the practicality of the Acid-base electronic chemistry comic learning media for teachers and students in senior high school. This study used the research and development method based on the Hanafin and Peck model that consists of three stages, namely needs analysis, design, and development and implementation. The results showed the validity value from the material expert was 85% with a very valid category and the media validity test with a value of 78.57% with a valid category. The results of the practicality test learning media were obtained from the teacher's response of 88.6% with very practical category and from the student's response of 82.4% with very practical category. Based on the results of the study, it could be concluded that the development of the Acid-base electronic chemistry comic learning media for high school students is valid and practical to be used as learning media.

INTRODUCTION

The 21st century learning paradigm implies that an educator is required to be able to use digital technology and communication facilities or networks to access, manage, evaluate, and create information so that it can be used in the learning process (Sutrisno, 2016). The 21st century is also characterized by (1) easily accessible information; (2) faster computing; (3) automation that replaces work; and (4) fast communication (Litbang KEMENDIKBUD, 2013). This is under PERMENDIKBUD No. 22 of 2016 concerning the standard of primary and secondary education processes. One of the contents of the standard process is the use of information and communication technology to improve efficiency and effectiveness in the learning process.

The condition of learning during the Covid-19 pandemic presents its challenges for educators. In this case, the face-to-face learning process is replaced by online learning process. This is also following regulation No. 4 of 2020 concerning the implementation of education policies in the emergency period of the spread of Covid-19, namely learning from home or distance learning using the assistance of technology. Here, the role of the teacher must be able to manage and apply information and communication technology in an integrated, systematic, and effective manner according to the situation and condition including utilizing technology to facilitate student learning activities both as a learning resource and media.

Based on the results of interviews with teachers at High School 5 Tanjungpinang, it was found that in the distance learning process, especially in chemistry subject, teachers only used electronic media in the form of PowerPoint and video links. The video used is the video that the teacher found on YouTube or in other words the video is not made by the teacher so sometimes it does not fully meet the needs of students.

Then looking at the conditions and developments of the current era, the development of android-based learning media is necessary to be

developed in the 21st century. Media in the learning process is an intermediary from the source of the message and the recipient of the message (Hamid et al., 2020). The use of media in learning can help students to receive and understand the subject matter optimally. Furthermore, the results of interviews with students at SMA Negeri 5 Tanjungpinang show that students experienced problems in boring and unpleasant learning conditions. The results of interviews with students also found that students are more interested in short and clear animated videos or illustrated media such as webtoons (web = online; toon = comics).

Based on the above problems, one of the solutions so that the media developed is attractive, easily accessible anywhere and anytime is the electronic chemistry comic learning media. Electronic comics are learning media that are presented in digital form in which there are pictures in a systematic order to form a story that can convey a message in a light and fun style (Aeni & Yusupa, 2018). Sugihartati (2010) also states that among today's youth, one of the most popular types of reading is graphic comics and popular fiction novels.

Based on the needs analysis and the results of interviews with teachers and students at High School 5 Tanjungpinang, Acid-base material is one of the chemistry subject materials that can be integrated into comic learning media. Acid-base is a material found in class XI High School. Acid-base material contains knowledge with factual, conceptual, and procedural dimensions. Acid-base is a prerequisite material for studying further materials such as buffer solutions. Therefore, this material requires a deeper understanding before studying the next material.

METHOD

The type of study used in this research is research and development (R&D). In this study, the model that was used referred to the Hannafin and Peck development model which has been simplified by Tegeh et al. (2014), which consists of three processes, i.e.: i) the needs assessment stage, ii) the design stage, and iii) the development and implementation stage. In this model, all stages involve an evaluation and revision processes.

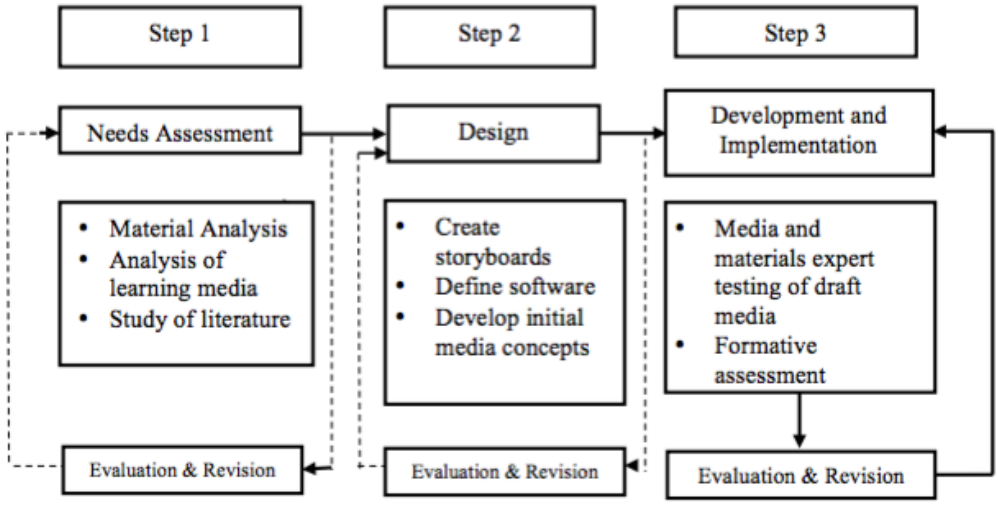

Figure 1. Electronic chemistry comic development research stage chart.

The data in this study was analyzed descriptive qualitatively, namely the data from the questionnaire validation sheet and the practicality of the developed media. The media and material validity assessment scale has four categories with the the highest score of 4 with strongly agree category and the lowest score is 1 with strongly disagree category. This is presented in Table 1.

Table 1. *Validity and Practicality Assessment Scale*

No	Category	Score
1	Strongly Agree (SS)	4
2	Agree (S)	3
3	Disagree (TS)	2
4	Strongly Disagree (STS)	1

The level of validity of the developed electronic chemistry comic learning media is measured using the following analytical technique (Sugiyono, 2015):

$$\% \text{ Validity} = \frac{\text{Overall Average}}{\text{highest score}} \text{X100\%.} \quad (1)$$

A Likert scale with four levels is used to determine the criteria for the validity of this media, and the answer to each instrument item has a gradation from very positive to very negative (Sugiyono, 2015). The criteria for the percentage validity of the media used is shown in Table 2.

Table 2**.** *Percentage of Validity Assessment*

No	Percentage	Information
1	81.26% - 100%	Very valid can be used without revision
2	62.51% - 81.25%	Valid can be used but needs minor revision
3	43.76% - 62.50%	Invalid, need major revision
4	25.00% - 43.75%	Very invalid, should not be used

The practicality level of the developed electronic chemistry comic learning media is measured using the following analytical technique:

$$\% \text{ Practicality} = \frac{\text{Overall Average}}{\text{Highest Score}} \text{X100\%.} \quad (2)$$

The practicality categories of the chemistry comics are presented in Table 3.

Table 3. *Percentage of Media Practicality Assessment by Teachers and Students*

No	Percentage	Information
1	81.26% - 100%	Very practical can be used without revision
2	62.51% - 81.25%	Practical or can be used but needs minor revision
3	43.76% - 62.50%	Not practical, recommended not to be used because it needs major revision
4	25.00% - 43.75%	Very impractical, should not be used

RESULTS

Results from this study is an electronic chemistry comic learning media on Acid-base material developed for high school students in class XI science that is valid and practical for use in the classroom learning process.

The stages of needs assessment in this research are problem and material analysis. Problem analysis aims to find information about the problems faced by teachers and students in learning. In this analysis, the researcher conducted a literature study and interviews. Based on the results of interviews and literature studies, it is found that the use of learning media in distance learning is still limited to the use of PowerPoint and videos sourced from YouTube. In the use of this media, there are complaints that the material is not delivered optimally. The results from student interviews that the learning media used by the teacher during the distance learning process is limited to PowerPoint and video links from YouTube. This makes learning problems for students who get bored quickly during the learning process and when asked to study independently. Electronic learning media that students want are fun, short, and clear media such as videos and fun picture media. Furthermore, students also like reading webtoons such as comics through Android. Based on the results of teacher and student interviews, it is necessary to develop learning media that are fun, interesting, and can be used in the distance learning process.

The development of learning media is aligned with the learning objectives contained in the learning implementation plan used by the teacher. The purpose of media development is the students can use electronic chemistry comics in learning to achieve learning objectives.

The second stage is the design stage. This stage is aimed to prepare the first design of the learning media product. The design stage is based on the results of the needs assessment in the previous stage. From the needs assessment stage, a research concept is compiled for the development of learning media for the electronic chemistry comics.

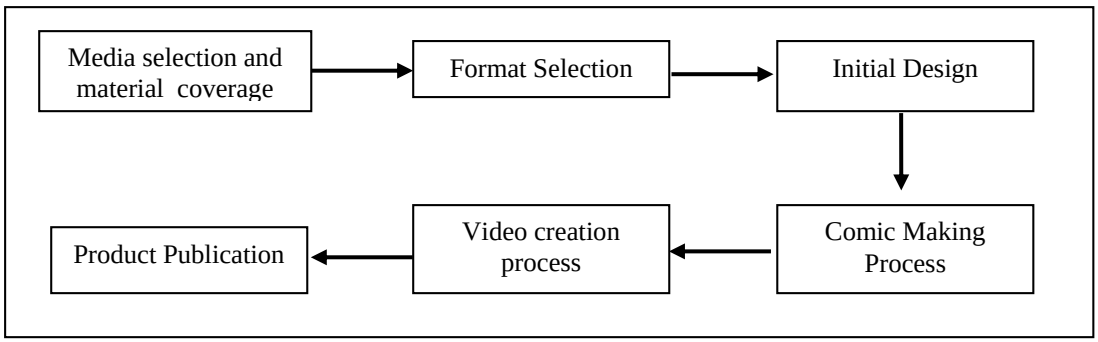

Figure 2. Electronic chemistry comic media concept chart.

The third stage is the development and implementation stage. This stage is carried out by making media, which is then validated by material and media experts before the media is implemented for students and teachers. The development of learning media for the chemistry comics begins with finding reference material that is included in comics and videos from textbooks commonly used by teachers.

The development of electronic chemistry comic media uses the *Jage.id* application. The learning media developed is named electronic chemistry comic as the name of the application icon. The navigation used is in the middle with the menu display as shown in Figure 3.

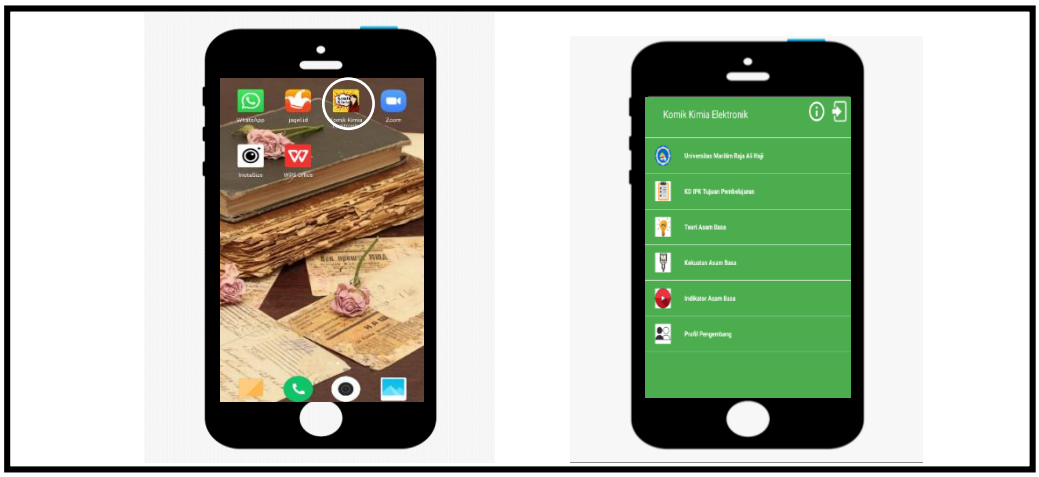

Figure 3. Electronic chemistry comic app icon display and electronic chemistry comic menu display.

A validation test is carried out to determine the validity of the developed media. The product validation carried out includes the validation of material and media experts. Material expert validation aims to test the quality of the material, the feasibility of the content, and the language of the electronic chemistry comic media. The results of material expert validation and suggestions for improvement by material experts can be seen in Table 4.

Table 4. *Material validation results*

No	Aspect	%	Criteria
First validation			
1	Material	58.3	Invalid
2	Feasibility of content	54.1	Invalid
3	Linguistics	75.0	Valid
Overall results		57.5	Invalid
Second validation			
1	Material	83.3	Very valid
2	Content feasibility	87.5	Very valid
3	Linguistics	75.0	Valid
Overall results		85.0	Very valid

Validation of media experts aims to assess the applications and displays contained in the developed electronic chemistry comic media. Based on the assessment given by the media experts, the results of the expert validation are presented in Table 5.

Table 5. *Media validation results*

No	Aspect	%	Criteria
1	Application	84.37	Very Valid
2	Display	70.83	Valid
Overall results		78.57	Valid

The validated electronic chemistry comic is then implemented for teachers and students. The implementation in this study consists of a teacher and students practicality test. The practicality test of students is carried out on 37 students with the results presented in Table 6. The teacher practicality test is carried out on one teacher with the results shown in Table 7.

Table 6. *Student practicality test results*

No	Assessment Indicator	%	Criteria
1	Media benefits	81.9	Very practical
2	Media quality	82.6	Very practical
3	Language	82, 4	Very practical
Overall results		82.4	Very practical

Table 7**.** *Teacher practicality test results*

No	Assessment Indicator	%	Criteria
1	Benefit	91.6%	Very practical
2	Quality	83.3%	Very practical
3	Language	100%	Very practical
Overall result		88.6%	Very Practical

DISCUSSION

This is a R&D study. R&D is a research method that develops and validates products so that they can be used in the learning process (Yulita, 2017). This study used the Hannafin and Peck model, which is simplified by Tegeh et al. (2014), which consisted of three main processes, namely the needs assessment stage, the design stage, and the development and implementation stage.

Needs analysis in learning includes problem and material analysis. The problem analysis shows that students feel that the media used by the teacher has caused problems for the students themselves. The learning media that is limited to PowerPoint and video links causes students to feel bored in the learning process. The use of PowerPoint according to Kamil (2018), requires special skills to convey good messages or ideas so that they are easily digested by the recipient. The learning media must remain relevant to the learning situation. Of course, teachers are required to innovate the learning media used to increase students' learning motivation, which will impact student's learning outcomes (Nurchaili, 2010). Based on the results of the needs assessment, it is obtained that students need interesting media in the learning process.

The second stage is the design stage, which aims to prepare the initial design of the product. This stage begins with the selection of media and material coverage, then the selection of formats, making initial designs in the form of storyboards, then making comics and videos and publishing products using the *Jigel.id* application. The third stage is development and implementation. At this stage, apart from the developed electronic chemistry comics learning media, instruments are also developed in the form of a validated questionnaire for validation tests and practicality questionnaires for implementation.

In the first validation, the overall validation result of the electronic chemistry comic learning media material is 57.5% with an invalid category. The material aspect is 58.3% with an invalid category, the content feasibility aspect is 54.1% with an invalid category and the linguistic aspect is 75% with a valid category. Invalid learning media cannot be disseminated or tested to students because the media is considered unfit for use. This is in line with what is conveyed by Sari & Suswanto (2017) that the media developed and declared invalid by the validator cannot be tested on students. A major revision is made to the learning media according to the suggestions of the material experts.

After the media is repaired and revised, a second validation is carried out. In the second validation, the overall result is 85% with a very valid category. The percentage of the last validation aspect is presented in Figure 4.

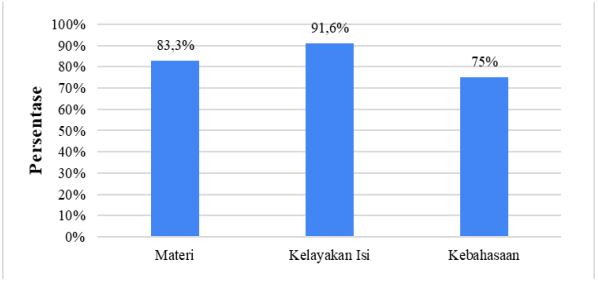

Figure 4. Material validation bar chart.

For the material aspect, the score obtained is 83.3% with very valid criteria, so that the material presented in the media is following the indicators and learning objectives. This is line with the notion of the learning media conveyed by Kustandi & Sutjipto (2013), that is learning media is a tool used to assist the learning process which serves to clarify the meaning of the message conveyed and to achieve learning objectives better.

In the aspect of content feasibility, the score obtained is 87.5% with a very valid category. This is in accordance to Wati (2016) stating that the learning media must contain accurate or reliable information to avoid student misunderstandings in translating information received through the media. In the linguistic aspect, the score obtained is 75% with a valid category, which is in accordance to the statement conveyed by Yuniati (2011) that the language in the learning media must be clear and should be in accordance to the rules of writing to facilitate the presentation or delivery of messages.

The media expert validation is carried out once by one validator. The result of the validation of the electronic chemistry comic learning media by the media expert is 78.5% with a valid category. This is presented in Figure 5.

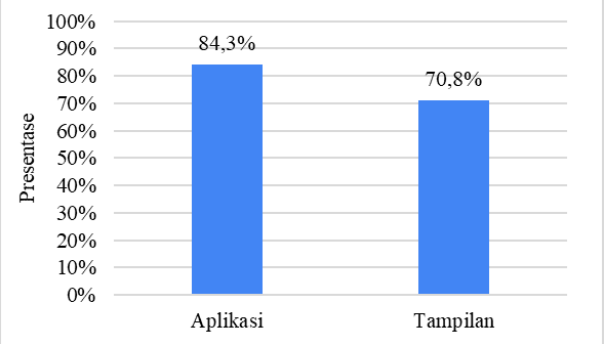

Figure 5. Media validation bar diagram.

The result of the validation by the media expert (Figure 5) for the application aspect is 84.3% with a very valid category as the electronic comic media is smooth in operation and easily accessible. The technology-based learning media can make it easier for teachers to communicate and interact with students, both inside and outside the classroom (Anshor, 2018). For the display aspect, the score obtained is 70.8% with a valid category, so that the developed media clear in conveying the material through the storylines and pictures. As stated by Kustandi & Sutjipto (2013), the display of images in the comics as graphic media has the aim of attracting attention, clarifying the material, illustrating facts and accelerating the delivery of information, and overcoming the limitations of observation.

The results of the validation test from the material and media experts produce learning media products in the format of apk. The media, which has been validated and declared valid, is then carried out for trial implementation to students. The implementation is carried out via online due to the Covid-19 pandemic. Practicality test on 37 students are carried out by distributing the application via a link and filling out a response questionnaire. The practicality results that have been tested on students of class XI IPA High School 5 Tanjungpinang produce a score of 84.4% with a very practical category. The results of the practicality test of students can be seen in Figure 6.

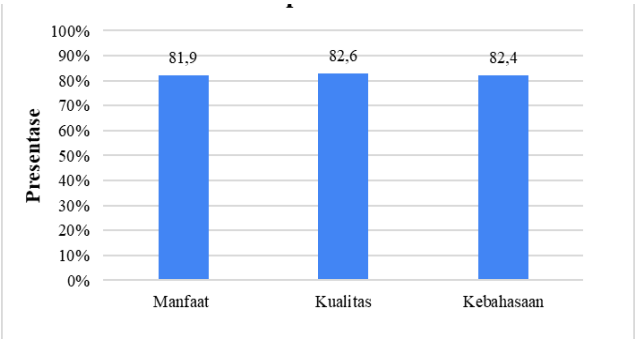

Figure 6. Bar diagram of the practicality test by students.

The score of the benefit aspect is 81.9% with a very practical category. One of the important elements in comics is the presentation of interesting images because it attracts the students' attention. In line with the opinion of Safitri & kabiba (2020), a good picture presentation can attract students' interest and motivation to learn. In the aspect of media quality, the result is 82.6% with a very practical category. The quality of the media is seen in terms of the storyline in conveying the material, the illustrations used, and the ease of accessing the media. Presentation of the material on the learning media affects students' interest in learning (Anwar, 2014). In the linguistic aspect, the score obtained is 82.4% with a very practical category. The use of good language in the learning media helps students to easily understand the material or information presented in the media.

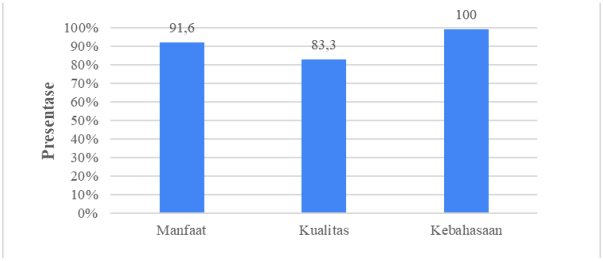

Figure 7. Bar diagram of teacher practicality test.

The teacher's practicality test is carried out to find out the practicality of the electronic chemistry comic media according to the teacher. The teacher's practicality test is conducted face-to-face. The results of the practicality test of the chemistry teacher at High School 5 Tanjungpinang can be seen in Figure 7.

The results of the practicality test of the teacher on the benefit, media quality, and linguistic aspects are 91.6%, 83.3%, and 100%, and all with very practical categories, respectively.

The results of the teacher practicality test as a whole is 88.6% with a very practical category. Hence, the media is declared practical, which means that the electronic chemistry comic can be used by teachers as learning media, especially on Acid-base material. The learning media can assist teachers in delivering material to achieve the ultimate goal of learning (Sapriyah, 2019).

CONCLUSION

Based on the results of the study, it can be concluded that the electronic chemistry comic learning media on the Acid-base material has been developed using the Hannafin and Peck research model consisting of needs assessment, design phase, and development and implementation stages. The media validation test containing application and display aspects produces a score of 78.57% with a valid category. The feasibility of content and linguistics obtain a score of 85% with a very valid and suitable category for use. The practicality results of the electronic chemistry comic learning media on the Acid-base material from student responses are 82.4% with very practical category and the teacher's response result is 88.6% with a very practical category.

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