PENGEMBANGAN MEDIA PEMBELAJARAN E-KOMIK MATERI REDUKSI DAN OKSIDADI BERBASIS *FLIP PDF PROFESSIONAL* PADA MODEL *DISCOVERY LEARNING*

DEVELOPMENT OF E-COMIC LEARNING MEDIA FOR REDUCTION AND OXIDATION MATERIAL BASED ON FLIP PDF PROFESSIONAL ON THE DISCOVERY LEARNING

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Abstrak

Penelitian pengembangan ini bertujuan untuk menghasilkan produk e-komik reaksi reduksi dan oksidasi berbasis *Flip PDF Professional* yang valid, praktis, dan efektif. Pengembangan e-komik ini mengacu pada model pengembangan ADDIE yang meliputi tahap analisis (*analysis*), tahap perancangan (*design*), tahap pengembangan (*development*), tahap implementasi (*implementation*), dan tahap evaluasi (*evaluate*). Subjek pada penelitian ini adalah masing-masing 2 orang ahli media dan ahli materi, 1 orang guru mata pelajaran kimia, serta 30 peserta didik kelas X MIPA 2 SMA Negeri 14 Makassar. Instrumen yang digunakan untuk kevalidan yaitu lembar validasi oleh ahli media dan ahli materi, kepraktisan yaitu lembar observasi keterlaksanaan pembelajaran e-komik, angket respon guru dan peserta didik, serta tes hasil belajar. Hasil penelitian ini adalah: (1) validitas e-komik dari ahli media sebesar 3,72 dan ahli materi sebesar 3,75 yang berada pada kategori sangat valid dengan uji konsistensi antar validator sebesar 100% yang berada pada kriteria sangat tinggi, (2) rata-rata persentase kepraktisan e-komik adalah 97%, dimana persentase kepraktisan berdasarkan angket respon guru dan peserta didik terhadap e-komik berturut-turut sebesar 100% dan 90,55% dengan kategori sangat praktis, 3) e-komik memenuhi kriteria efektif (≥85%) berdasarkan pencapaian ketuntasan kelas dengan persentase 86.67%. Berdasarkan data tersebut, disimpulkan bahwa e-komik reaksi reduksi dan oksidasi berbasis *Flip PDF Professional* yang dikembangkan dengan model ADDIE bersifat valid, praktis, dan efektif untuk digunakan dalam pembelajaran.
Kata kunci: *E-Komik ,Reaksi Reduksi dan Oksidasi, Flip PDF Professional.*

Abstract

This research and development aims to produce a valid, practical, and effective e-comic reduction and oxidation reaction based Flip PDF Professional. The development of this e-comic refers to the ADDIE development model which includes the analysis stage, the design stage, the development stage, the implementation stage, and the evaluation stage. The subjects in this study were 2 media experts and material experts, 1 people of chemistry teacher, and 30 students of class X MIPA 2 SMA Negeri 14 Makassar. The instruments used for validity are validation sheets by media experts and material experts, practicality, namely observation sheets on the implementation of e-comic, teacher and student response questionnaires, and learning outcomes tests. The results of this study are: (1) the validity of the digital comic from the media expert is 3.72 and the material expert is 3.75 which is in the very valid category with a consistency test between validators are 100% which is in very high criteria, (2) the average percentage of e-comic practicality is 97%, where the percentage of practicality based on the questionnaire responses of teachers and students to digital comic are 100% and 90,55% in the very practical category, 3) e-comic meet the effective criteria (≥85%) based on the achievement of class completeness with percentage 86.67%. Based on these data, it is concluded that the e-comic reduction and oxidation reaction based Flip PDF Professional developed with the ADDIE model is valid, practical, and effective for use in learning.
Keywords: *E-Comic, Reduction and Oxidation Reaction, Flip PDF Professional*

INTRODUCTION

Education is a conscious process of developing self-knowledge and abilities. Education in Indonesia must be improved immediately to be able to give birth to a generation that has advantages in various fields so that the Indonesian nation can compete with other nations. Improving the quality of human resources through educational channels ranging from primary and secondary education to higher education is the key to being able to follow the development of the Industrial Revolution 4.0 (Lase,

2019). This 21st-century learning applies creativity, critical thinking, cooperation, problem-solving, communication skills, community, and character skills [1].

Government policies in developing the potential of students have been carried out marked by changes in the curriculum which is one of the educational tools that contains learning planning. The 2013 curriculum is competency learning by strengthening authentic learning and assessment processes to achieve spiritual, social, knowledge, and skill competencies [2]. The discovery learning model is a learner-centered learning model that involves the ability to investigate and find students systematically, creatively, and logically [3]. The advantage of the discovery learning model is that the knowledge gained can strengthen understanding and memory so that it can improve cognitive skills and processes, encourage students to think and work on their initiative, and is effective in improving students' chemistry learning outcomes [4].

Based on the results of initial observations and interviews with teachers and students of SMAN 14 Makassar on November 3, 2021, there were several obstacles when learning activities took place, one of which was the media used. Teachers use textbooks that are substituted with YouTube videos as student learning materials. In addition, the teacher does not conduct virtual class meetings during the chemistry learning process but only uses Google Classroom as a medium for distributing material video links from YouTube. Therefore, students find it difficult to find concepts in the material and it is hard to understand calculations because there is no virtual meeting class. It will have an impact on the low learning outcomes of students.

Yerimadesi et al. (2018) stated that students find it hard to apply redox concepts to explain chemical phenomena experienced in everyday life [5]. Conceptual errors were being experienced by students in the results of Andriane et al. (2018) research showing that students still experience errors in distinguishing between redox reactions and non-redox reactions [6]. Reduction and oxidation reaction material is one of the chemistry subjects that are not only memorized but must be understood well. Reduction and oxidation material is one of several difficult chemistry subject materials, that have many concepts, including the redox reactions based on the electron transfer concept. Therefore, to improve the quality of student learning outcomes, teachers need to use appropriate learning media and are liked by students.

One of the learning media that can be developed is e-comic. Comics are systematic and orderly stories that make it easier for readers to follow and understand the contents of the comics. Comics are a medium that tells illustrated stories, where images serve to describe stories so that readers can easily understand the stories conveyed [7]. If a comic were designed properly, precisely, and correctly, it can be used as a pedagogical source in learning.

E-comic is a product of technological advances in the field of communication and information. Comic considerations are made in electronic form because it makes it easy for students to access them anytime and anywhere. Wankel & Blessinger (2013) revealed that a person can learn better by combining pictures and writing [8]. In addition, electronic comics can also be presented with audio so that students do not get bored quickly. It is in line with what was stated by Comer (2015) that combining words, pictures, gestures, and audio provides an experience for students [9]. So, e-comic is an innovation in the development of learning media that can be used in learning activities to help students be more active and make learning more fun.

The use of chemical comics as a learning medium by Enawati and Sari (2010), it was found that the learning tendency of students was increasing, 96.67% of students experienced an increase in learning outcomes through the use of learning media in the form of comics [10]. The research of Murtiningrum et al. (2013) stated that the e-comic media in the learning process can increase the enthusiasm for learning and the ability to think abstractly of students [11]. In addition, this e-comic can help students to think critically and be more optimum, making it easier to understand chemistry, especially reduction and oxidation reactions.

Learning media should be design as attractive as possible. The software that can be used to create interest and easy-to-use learning media is Flip PDF Professional. Flip PDF Professional is an application that can be used to convert PDF publications to digital flipping pages that allow us to create interactive learning content with several supporting features [12]. Flip pdf professional application can create interactive e-comic pages by including various multimedia such as images, videos from youtube, MP4, audio, video, hyperlink, Macromedia flash animation, etc. [13].

The Flip PDF Professional application has a variety of features with a page editing function that is very easy to use so that the resulting e-comic was integrated well between audio, visual, and text in a single unit. Reduction and oxidation reaction material that presented in e-comic can be visualized clearly through learning videos and relevant pictures. In addition, e-comic based Flip PDF Professional can be used online or offline and can be studied anytime and anywhere via smartphones or computers by students. The use of e-comic based Flip PDF Professional as a

learning media can increase students' motivation because the learning process is more interactive and fun [14].

The discovery learning model is one of the learning models that student-centered so that it involves the ability to investigate and find students systematically, creatively, and logistically [3]. The advantage of the discovery learning model is that the knowledge gained strengthens understanding and memory so that it can improve skills and cognitive processes, encourage students to learn and work on their own initiative and is effective in improving student learning outcomes [4].

Based on the introduction to the problem above, researchers are interested in making an e-comic learning media that is feasible and practical to use in learning using the discovery learning model. So that the researcher intends to conduct a study with the title "Development of E-Comic Learning Media for Reduction and Oxidation Reaction Materials Based on Flip PDF Professional on the Discovery Learning Model".

METHOD

This study uses research and development methods. The development model used is the ADDIE model. The ADDIE model consists of five stages, namely analysis, design (planning), development, implementation, and evaluation [15].

E-comics are implemented in the learning process at SMA Negeri 14 Makassar in the even semester of the 2021/2022 academic year. The subjects of this research are media and material experts to determine the validity of e-comics. Then, 1 teacher of chemistry studies and the students of class X MIPA 2 consist of 30 people to determine the practicality of e-comics, and the students were also respondents for the effectiveness of e-comics.

The research instrument used was a validity instrument in the form of a media expert and material expert validation sheet, a practical instrument in the form of a media implementation observation sheet and teacher and student response questionnaires, and an effective instrument in the form of student learning outcomes tests.

Data analysis techniques used in this study are qualitative and quantitative data analysis techniques. Qualitative analysis used during validation is data in the form of input, suggestions, and criticism of e-comic. Meanwhile, quantitative analysis was carried out on the results of the validity test which had been filled in by media experts and material experts. As well as the results of practicality tests that have been given by chemistry subject teachers and students who use this media. Analysis

of the results of the validation of the feasibility of e-comic using a Likert scale percentage score.

According to Widyoko (2016) the criteria for media validity are group into 4 category, there are very valid with a score of >3.20, valid with a score of 2.40 < X 3.20, less valid with a score of 1.60 < X 2.40, and invalid with a score of score 0.80 < X 1.60 [16]. Meanwhile, according to Akbar (2013) the criteria for practicality of media are grouped into 4 category, there are very practical with a score of 75.01-100%, practical with a score of 50.01-75.00%, less practical with a score of 25.01-50.00%, and impractical with a score of 00-00.00% [17]. And then, the criteria for implementing the equipment are grouped into 5 category, there are very high with a value of 81-100%, high with a value of 61-80%, moderate with a value of 41-60%, low with a value of 21-40%, and very low with a value of 5-20%.

RESULT AND DISCUSSION

This R&D research uses the ADDIE development model which consists of Analysis as the first stage. At this stage, the researcher conducts field and needs analysis as a basis for development. Field analysis shows that teachers have used learning media, but in terms of the attractiveness and novelty of the media used have not been able to make chemistry subjects being interesting. In addition, the limited hours of chemistry lessons so that learning takes place less than optimally. Needs analysis resulted that learning media innovation is needed that can increase learning motivation and can be utilized optimally by students, and following the demands of the 2013 curriculum requires students to play an active, independent, and critical thinking role in the learning process.

The second stage is design. For this stage several steps are carried out, namely making e-comic, and research instruments. E-comic redox was designed using many applications such as Canva, Microsoft Word, Google Form, and Flip PDF Professional.
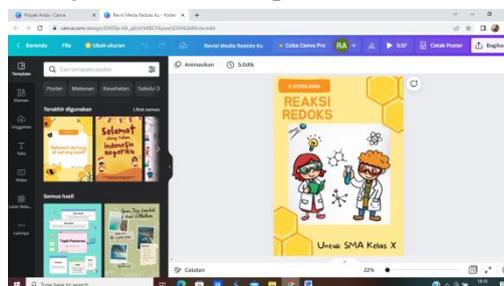

Figure 1. The e-comic design process using Canva

Development stage, products that have been designed are realized into products that are ready to be implemented, which are validated by media experts and material experts first.

Media expert validation was carried out by 2 people, each of whom was a chemical engineering

lecturer at the Ujung Pandang State Polytechnic and a Makassar State University Engineering lecturer. Validation by media experts covers two aspects, namely programming aspects and media display or design aspects. The data from the validation results by media experts are as follows:

Table 1. Media Expert Data

Validation Aspect	V1	V2	Average Score	Category
Programming	4	3,75	3,88	Very Valid
Display	3,81	3,28	3,55	Very Valid
Average			3,72	Very Valid

At this stage, the e-comic was revised based on suggestions given by media experts. One of the improvements to e-comic media based on the input suggestion is to increase the font size.

Then e-comic is validated by material experts. This validation consists of three aspects, namely aspects of material content, material presentation, and language feasibility. The aspect of the material content aims to determine the suitability of the material presented by the expected basic competencies. The aspect of material presentation aims to find out whether the material presented is arranged systematically to fulfill the basic competencies. Meanwhile, the language feasibility aspect aims to find out whether the language used in the content is easy to understand and clear. The data from the validation by material experts are as follows:

Table 2. Material Expert Data

Validation Aspect	V1	V2	Average Score	Category
Content Material	3,83	3,83	3,83	Very Valid
Material Presentation	3,83	4	3,92	Very Valid
Languange Feasibility	3,50	3,50	3,50	Very Valid
Average			3,75	Very Valid

One of the improvements to the e-comic media based on the advice of the material experts provide is to adjust the number of evaluation questions with the number of learning objectives.

Implement, this stage is carried out after the product developed is declared valid and ready to be implemented in the learning process. Media implementation is carried out at SMA Negeri 14 Makassar in the even semester of the 2021/2022 academic year. E-comic is implemented in the learning process in class X MIPA 2 which consist of 30 students that will become respondents to find out the practicality and effectiveness of the developed e-comic. The practicality of e-comic is assessed from the observation sheet on the implementation of learning, also student and teacher response questionnaires.

Figure *2*. The implementation of E-Comic on SMA Negeri 14 Makassar

Table 3. Recapitulation of Student Response Results

No.	Assesment Aspect	Percentage	Category
1	Easy of Use	89%	Very Practical
2.	Appearance	92,66%	Very Practical
3.	Media Benefit	90%	Very Practical
	Average	90,55%	Very Practical

Table 4. Recapitulation of Teacher Response Results

No	Assesment Aspect	Percentage	Category
1.	Easy of Use	100%	Very Practical
2.	Appearance	100%	Very Practical
3.	Media Benefits	100%	Very Practical
4.	Content	100%	Very Practical
	Average	100%	Very Practical

Meanwhile, the observation sheet for the implementation of the e-comic is used to see the implementation of the developed media which is filled out by the observer. The following are the results of the learning implementation observation sheet.

Table 5. Results of Observation of the Implementation of Learning Media

No	Aspect	Average Percentage (%)	Category
1.	Preliminary Stage	100	Very High

2.	*Stimulus*	100	Very High
3.	*Problem Statment*	100	Very High
4.	*Data Collection*	100	Very High
5.	*Data Processing*	100	Very High
6.	*Verification*	89	Very High
7.	*Generalization*	83,5	Very High
8.	Closing Stage	100	Very High
	Average Total	97	Very High

In addition, to determine the effectiveness of e-comic, a learning outcome test is given to measure the ability of students which is carried out using Google From which consists of 25 multiple choice questions. The following are the results of the student learning outcomes test:

Table 6. Results of Descriptive Analysis of Student Learning Outcomes Test

Variable	Deskriptive Value
	X MIPA 2
Research Subject	30
Ideal Score	100
MCC	75
Average	86
Maksimum Score	100
Minimum Score	60
Number of Completed Students	26
Number of Uncompleted Studnets	4
Class Completion Percentage	86,67%

Evaluate, carried out at every stage of the process from the analysis stage to implementation by using a limited evaluation to produce e-comic that is suitable for use in learning.

1. Discussion

a. E-Comic Development Based on Flip PDF Professional

The development of this e-comic learning media uses the ADDIE model which produces valid, practical, and effective learning media. The ADDIE model consists of the following stages including Analysis, Design, Development, Implement and Evaluate).

Analysis, in this stage two activities are carried out, namely field study analysis and needs analysis. The field analysis was obtained if the media used by the teacher in learning was still limited to media only in the form of YouTube videos which were substituted with printed books and modules from the Ministry of Education and Culture which were distributed through Whatsapp groups. The

chemistry material given by the teacher is less effective because it only outlines the matter without further explanation. In addition, the modules used in the learning process are classified as very monotonous and hard to understand because there are only text and images that are not colored.

Based on the needs analysis, three activities were carried out. Curriculum analysis adapted to the basic competencies to be achieved in the redox reaction sub-material, characteristic analysis adapted to the diverse characteristics of students which can be used as an illustration in developing e-comic and material analysis carried out by identifying the material principal by arranging redox reaction sub materials.

Design, this stage includes collecting materials and images, selecting applications, and compiling content and instruments used in the form of validation sheets, observation sheets, and questionnaires compiled to evaluate the e-comic that has been developed.

Development, realizing a initial product into a product in the form of an e-comic that is ready to be implemented. This stage is also validated by media experts and material experts to determine the feasibility of e-comic before being used in the learning process. This is in line with research by Hayati (2015) that to obtain the validity of the developed media, data from the assessment of media experts and material experts were used.

Implement, for this stage a valid e-comic is implemented at SMAN 14 Makassar in class X MIPA 2 with 30 students. The purpose of this implementation is to see the implementation of this media in learning and to know the practicality and effectiveness of the developed e-comic media. The practicality of e-comic is based on the results of the observation sheet on the implementation of learning. It is applied in the discovery learning model which consists of 6 stages, namely stimulus, problem identification, data collection, data processing, verification, and generalization. In addition, the practicality of e-comic is also assessed from student response questionnaires and teacher response questionnaires. To find out the effectiveness based on the test of student learning outcomes.

Evaluation, in this stage, is carried out by revising the shortcomings of the e-comic that was developed based on the suggestions for improvement given. The evaluation stage is very important to evaluate each step to achieve the goal with the design and instructional materials to meet the needs of students. The evaluation stage carried out is a limited evaluation. This stage is carried out at each stage so that later it can produce an e-comic that is valid, practical and effectively used in the learning process.

b. Validity, Practicality, dan Effectivity of *E-Comik* based on *Flip PDF Professional*

1) Validity

The assessment of media experts covers programming and display aspects. Based on Table 1, the programming aspect obtained an average score of 3.88 with a very valid category. This shows that the e-comic media developed is easy to use in the learning process. This is following Thorn's statement in Munir (2009) who differs that one of the criteria for assessing a good media must have ease of navigation [18]. Interactive media should be designed as simple as possible so that learners can learn it without having to have complex knowledge about media. Therefore, the developed e-comic meets the programming/navigation aspect criteria.

The aspect of the display that was assessed obtained an average score from the two media experts, namely 3.55 with a very valid category. Based on the results of this validation, it can be seen that the developed e-comic has an attractive appearance and informative content. This is in line with the opinion of Levie and Lentz [19] that learning media has an attention function, namely attracting the attention of students to concentrate on the content of the lesson related to the visual meaning displayed or accompanying the lesson text.

Material expert assessment includes three aspects, namely aspects of material content, material presentation, and language feasibility. Based on Table 2, the aspect of material content obtained an average score of 3.83 in the very valid category. This shows that the material contained in the e-comic is in accordance with the fulfillment of basic competencies in redox reaction material as well as learning images and videos that are displayed in harmony with the material presented. In addition, according to Chee and Wong (2003) good media have pictures, photos, animations and videos that can illustrate concepts in real life and can provide direct examples of use with the application of a science being studied.

The aspect of presenting the material obtained an average score of 3.92 from the two experts with a very valid category. This shows that the material presented in the e-comic presented has a clear source and a coherent presentation so that students gain knowledge clearly and make it easier to learn the material presented. While the language feasibility aspect obtained an average score of 3.50 with a very valid category. This shows that the language used in e-comic is easy to understand and in accordance with the level of development of students who will use learning media. This is in accordance with Walker & Hess's statement in

Arsyad (2014) which explains that media must have technical qualities which include: readability, quality of handling student responses, quality of program management, and quality of documentation [19].

The average score for all aspects of the assessment of material experts is 3.75. If converted based on the table of validity criteria according to Widyoko (2016), the results of the e-comic validity assessment are in the very valid category [16]. The final result of the analysis of the material expert's assessment shows the value of the validity criterion of 1.00 in accordance with the validity criteria according to Gregory in table 3.8., then the value is at a very high criterion with a consistency test between validators of 100%.

2) Practicality

The practicality was obtained by the results of the observation sheet on the implementation, the student questionnaires, and the teacher questionnaires. The results of the implementation of learning using the discovery learning model showed very high results. Which indicates that the learning aspect of using e-comic teaching materials in online learning using Google Meet meets the practical criteria based on Table 5. This is shown by all steps that have an implementation rate of more than 80% with the average percentage for all stages in the learning process obtained by 97% with a very high category.

The results of the student response questionnaire and the teacher's response aspects show that the developed e-comic is very practical to use in the learning process. This practicality is assessed from several aspects, namely ease of use, appearance, and media benefits. Based on student responses (Table 3) and teacher responses (Table 4), it is known that the ease of use aspect obtained a percentage of student responses of 89% which is in the very practical category. Meanwhile, the teacher's response to the ease of e-comic aspect obtained a percentage of 100% in the very practical category. This shows that the developed e-comic is easy and practical to use in the learning process.

The display aspect of the students received a positive response of 92.66% and from the teacher 100% who were in the very practical category. It shows that the appearance of the developed e-comic is attractive in terms of design, easy to read, and the images and videos presented to make it easier for students to learn. Aspects of the benefits of the media obtained a student response of 90.55% and a teacher response of 100% with a very practical category. This shows that the developed e-comic provides benefits for students in the learning process.This is in line with the research of Hutahaean et al (2019) that the more senses are used to receive

information, the more likely the information is to be remembered and understood. Experts prove a prominent difference in learning outcomes obtained through the senses of sight and hearing (Prihantana, 2014).

The results of the questionnaire analysis of the observation of the implementation of learning media as well as the questionnaire responses of teachers and students as a whole gave a positive response to e-comic, so it can be concluded that the e-comic developed was declared feasible in terms of practicality. This is in line with Mustaming (2015) if practicality refers to how far users (or other experts) consider the device to be attractive and usable under normal conditions [20]. Thus, e-comic is declared practical if the experts and practitioners state that theoretically e-comic can be applied in the field and the level of implementation is categorized as 'good'.

3) E-*Comic Effectivity*

The effectiveness of the developed e-comic can be known by the student learning outcomes test. It determines the cognitive level of students towards the redox reaction material being taught. The developed media is declared effective if the class completeness reaches 85% based on the KKM applicable at the school, which is 75.

The results from the test of student learning outcomes with a percentage of class completeness of 86.67% (table 4.10) which shows that the developed media is effectively used in the learning process. This is in line with the regulation of the Ministry of National Education (2008) that learning is said to be complete if classically students who complete based on the KKM reach 85% of the total number of students.

Based on the results of the analysis of the validity, practicality, and effectiveness of the developed learning media, it can be seen that the developed e-comic meets the criteria for use in the learning process. This is in accordance with Akker's opinion [21] which states that producing good quality learning products, must meet three criteria, namely validity, practicality, and effectiveness.

CONCLUSSION

Research and development of e-comic learning media with the Discovery Learning model on the reduction and oxidation reaction materials that have been carried out can be concluded that:
a. Flip PDF Professional-based redox reaction e-comic was developed using the ADDIE model which consists of five stages, namely: a) Analysis stage

which consists of performance analysis, namely analyzing problems faced by teachers and students during the learning process and needs analysis carried out by three activities which include:: curriculum analysis, student characteristics analysis, and material analysis. b) The design phase includes designing research instruments, learning tools, designing e-comics, and creating e-comic designs using Canva, Microsoft Word, and Flip PDF Professional software. c) The development stage includes e-comics that have been designed and designed then validated by media experts and material experts and revised based on suggestions and inputs given by media experts and material experts. d) The implementation phase includes valid e-comics implemented in the learning process at SMAN 14 Makassar to determine the practicality and effectiveness of e-comics. e) The evaluation stage is carried out at every stage in the e-comic development process to produce an e-comic that is suitable for use.
b. Flip PDF Professional-based redox reaction e-comic media meets the criteria for use. This feasibility is based on the validity value of media experts and material experts who state that e-comics are very valid, practicality is obtained based on the observation sheet on the implementation of learning media and questionnaire responses from teachers and students stating that e-comics are very practical in their use and the effectiveness of e-comics is obtained from the test results. students who stated that e-comic met the criteria for effective use.

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