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DEVELOPMENT OF VERTEBRATE DIVERSITY COMICS IN THE MOUNT PUNTANG AREA AS A LEARNING MEDIUM

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Keywords
Educational comics, vertebrate diversity, Mount Puntang, 3-D models, learning media

Abstract
Visual media - based education is an innovative strategy For increase interest Study student to material complex , including diversity life . One of effort For support learning This is through development comic education based on local . Research This focused on development comic education about vertebrate diversity in the region Mountain The Puntland as an innovative, interesting and relevant learning media. Research This use Research and Development (R&D) method with 3-D model stages (Define, Design, Develop). Qualitative data collected through interview with teachers and experts For identify learning media needs, while quantitative data obtained from validation products by experts materials, media experts, and teachers, as well as readability tests by students.
Research result show that comic this is valid and effective as a learning medium. Validation expert material to obtain average score 88%, validation media expert 83%, and science teacher validation 86%, all of which including in very valid category. Readability test by students show average score of 88%, with media aspects reach mark highest by 94%. This comic rated capable interesting attention students, improve understanding to material diversity life, and grow awareness will importance conservation diversity local life. Study This give implications significant in development teaching materials based on local. This comic No only can used as a learning medium but also as tool For increase awareness student will importance preservation environment. With thus, comics This potential become a learning medium supporting alternatives achievement objective education national.

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INTRODUCTION

In the era of globalization and revolution Industry 4.0, education around the world is facing challenge big in create method innovative, interesting and relevant learning for generation young. One of the the approach that begins popular is use of media based technology and visuals such as comics, animation, and interactive multimedia (Firmadani, 2020). Visual media such as comic has proven effective in increase interest and involvement students, especially in understand complex concept (Arsyad, 2016). Diversity life, especially vertebrates, becomes issue important in education environment Because related direct with sustainability nature and consciousness student to importance conservation (Indy et al., 2019).

In Indonesia, education about diversity biological Still face obstacles, especially in matter provision of appropriate learning media. The diversity of vertebrates in the area Mountain Puntang, which is rich in species endemic and unique, not yet Lots integrated to in curriculum formal education. In fact, the introduction diversity This own potential big For increase understanding student about importance ecosystem local and global (Ariani et al.,

2022). Lack teaching materials based on local and innovative media like comic become obstacle in develop effective learning (Mulyati, 2002).

Use of learning media based on comic become potential solutions For overcome problem This. Comics have ability For convey information with an interesting , simple and easy way understood by students from various level education (Meisyawati et al., 2018). Research show that comic media can increase results Study students, especially in understanding reading and skills think critical (Mohid et al., 2015). With Thus, development comic about vertebrate diversity in the area Mountain The Puntland as a learning medium become very urgent For done.

Development teaching materials based on comic has Lots researched and shown positive results. For example, research by Haka and Suhada (2018) developed biology manga comic Android based for successful high school students increase interest learning and understanding draft students . Another study by Irfana et al. (2017) showed that digital comics about viruses can become an effective media in learning biology. In addition, Al- Tabany (2014) emphasized importance designing contextual and progressive learning models For fulfil need students in the 21st century.

Instructional Media based on technology also becomes attention important in development teaching materials. According to Fitri and Ardipal (2021), learning videos designed with application Kinemaster can increase effectiveness learning thematic. In addition, Rohimah et al. (2020) showed that e-learning can increase ability think creative student .

Study This offer approach new in development of learning media with focus on integration vertebrate diversity in the area Mountain The Puntland to in form comics. Not only depend on interesting illustrations, comics this will also equipped with content educative based on relevant local data . Approach This different from study previously Because prioritize use diversity biological local as contextual teaching materials, appropriate with Ministry of National Education guidelines (2004).

Study This aiming For Developing learning media in the form of comic about vertebrate diversity in the area Mountain Puntang . Evaluate effectiveness comic as a learning medium in increase understanding and interest student to diversity life. Giving contribution real to development teaching materials based on relevant local with need curriculum.

RESEARCH METHODS

Study This use Research and Development (R&D) method with 3-D model stages (Define, Design, Develop). This method chosen Because aiming For develop and produce product in the form of comic valid, interesting and effective education used as a learning medium (Al- Tabany , 2014).

The approach used in study This is approach qualitative and quantitative. Qualitative data in the form of suggestions and opinions media expert, expert materials, and teachers towards the learning media developed. Quantitative data obtained from validation products by experts and readability tests participant educate through questionnaire. Population, All MTs students who become target user comic vertebrate diversity, as well as eye teachers relevant lessons in the region research. Sample, Sample selected in a way purposive, including expert validators material, media expert, eye teacher science lessons, and 30 students were used for trial legibility comics.

Collection Techniques, Observation, Observing need learning and potential local diversity life in the area Mountain Puntang. Interview, Conducted with teacher for know learning media needs as well as input expert to design comic. Questionnaire Validation , Used For evaluate validity product from aspect materials , media, and readability. Documentation, in the form of supporting data collection like Illustrations and content adapted education to in comics.

Data Analysis Techniques Analysis Qualitative , Used For interpret results interview and feedback from the validator, so that product can customized with need learning. Analysis Quantitative, Using percentage For evaluate validity and readability comic. Average score counted For determine eligibility product. Criteria validation based on Riduwan & Sunarto

(2017) are : Very valid: 81%-100%, Valid: 61%-80%, Not valid: <60%, Comic media products that have been validated will tested readability in students For evaluate effectiveness its use as a learning medium .

RESULTS AND DISCUSSION

RESULTS

Define

The first is the Definition stage, Activities at this stage are carried out to determine and explain the development conditions. The data obtained are based on the results of an interview with a biology teacher, Mrs. Rika. This interview was conducted to obtain information about the learning process at MTs Nurrohmah 2, namely 1) the curriculum used, 2) the science learning process that teachers often write on the board, 3) the learning media used only limited to LKS and books package , and the use of cardboard media is said to not meet the needs of students and the needs of implementing local potential in the region so that students gain new knowledge. Therefore, product development is carried out based on the main idea of the problem obtained from the interview results. Task analysis is carried out to determine the Learning Outcomes (CP) that will be used to compile comics where CP is selected based on the material taken based on the curriculum used by the school. The curriculum implemented at MTs Nurrohmah 2 is the Independent Curriculum. Based on the analysis of learning outcomes for biology subjects for grade VII or stage D in the independent curriculum, the material is developed in comics, namely the material on biodiversity which is Sub CHAPTER 7.1 of the material on Biodiversity and Ecology. The Independent Curriculum contains two main elements in learning outcomes, namely the element of understanding science and the element of process skills. Details of learning outcomes in study This served in table following :

Table 1. Learning Outcomes on Biodiversity Material

Element	Phase D
Understanding Science	At the end of phase D, students identify interactions between living things and their environment.
Process Skills	1. Watch 2. Questioning and predicting 3. Planning and conducting investigations 4. Processing, analyzing data and information

Next, formulate learning objectives related to learning outcomes (CP). This is because in making vertebrate diversity comics, learning objectives are formulated based on the learning outcomes that have been analyzed. In formulating learning objectives, this is not made by the government but by the subject teachers themselves. In designing learning, the main task of the teacher is to formulate specific learning objectives and subject matter (Putrianingsih et al., 2021).

The learning objectives are:

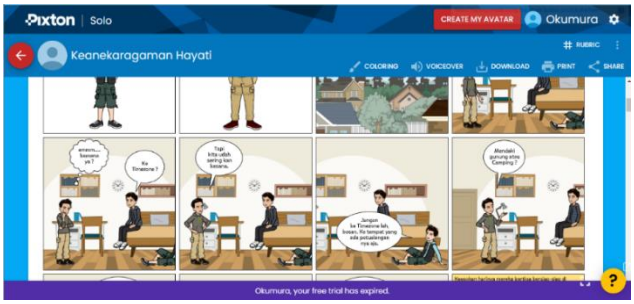
a. Identify vertebrate species and explain the interactions of living things with the environment and their conservation in the Mount Puntang area.
b. Creating visual works about biodiversity in the Mount Puntang area.

Design

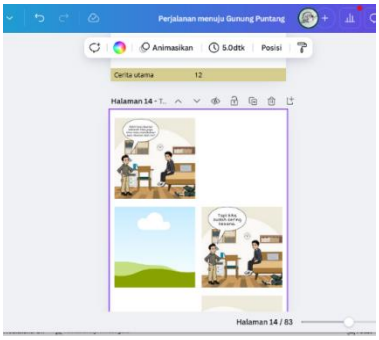
The second is the Design stage, the activity at this stage is designing learning media. This design stage begins with determining the media design and product development aimed at a comic compilation format consisting of several components including covers, CP and TP, reading procedures, character introduction, and storyline. The data obtained at *the determination stage is used* as a reference in designing the comic draft. Furthermore, the selection of media, based on the results of a preliminary study through interviews with teachers and students, that the learning process that takes place in this material is accustomed to the lecture method and teachers often write on the board, which makes students feel bored

and less able to understand the material because the delivery of the material is less interesting and limited. So that media is needed that can be interesting in the learning process.

The tools used in designing comics are the Pixton and Canva applications. The Pixton application is used to design comic illustrations and conversation dialogues. After the color illustration is successfully created, the comic panel set via application canva .



Gambar 1. Membuat Panel Komik Melalui Aplikasi Pixton



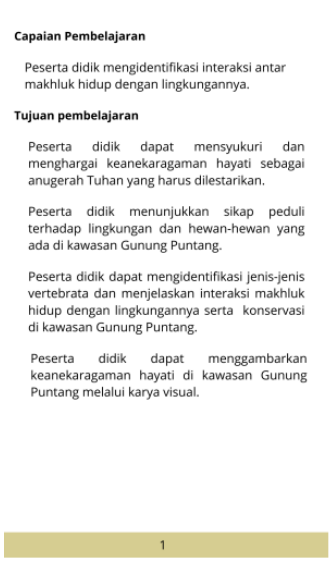
Gambar 2. Menempatkan Panel Komik di Aplikasi Canva

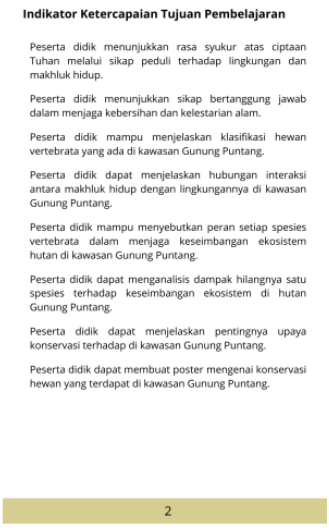
Next, a format is selected to plan the appearance and presentation of the developed media product according to the script, image illustrations, conversation dialogues, and storylines. Vertebrate diversity comics as a learning medium for biodiversity material are presented in the form of informative and interactive comics.

The initial design of the comic that was developed can be seen in Figure 3. Below:

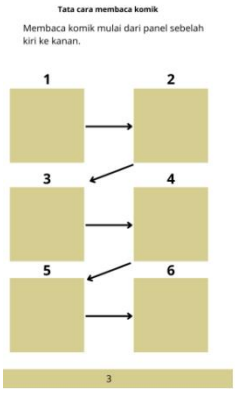
(seb (b) (c)


Tiba di depan gerbang masuk Gunung Puntang.
Anak-anak, Ayah sudah sampaikan ke pemandu kalian, namanya Pak Budi. Nanti kalian akan dipandu oleh beliau.
Selama perjalanan kalian harus nurut dan ikuti arahan dari Pak Budi ya.
Baik Ayah.
Halo anak-anak. Perkenalkan nama bapak, Budi. Bapak yang akan menjadi pemandu kalian selama perjalanan disini.
Main Story 19


Capaian Pembelajaran
Peserta didik mengidentifikasi interaksi antar makhluk hidup dengan lingkungannya.
Tujuan pembelajaran
Peserta didik dapat mensyukuri dan menghargai keanekaragaman hayati sebagai anugerah Tuhan yang harus dilestarikan.
Peserta didik menunjukkan sikap peduli terhadap lingkungan dan hewan-hewan yang ada di kawasan Gunung Puntang.
Peserta didik dapat mengidentifikasi jenis-jenis vertebrata dan menjelaskan interaksi makhluk hidup dengan lingkungannya serta konservasi di kawasan Gunung Puntang.
Peserta didik dapat menggambarkan keanekaragaman hayati di kawasan Gunung Puntang melalui karya visual.
1


Indikator Ketercapaian Tujuan Pembelajaran
Peserta didik menunjukkan rasa syukur atas ciptaan Tuhan melalui sikap peduli terhadap lingkungan dan makhluk hidup.
Peserta didik menunjukkan sikap bertanggung jawab dalam menjaga kebersihan dan kelestarian alam.
Peserta didik mampu menjelaskan klasifikasi hewan vertebrata yang ada di kawasan Gunung Puntang.
Peserta didik dapat menjelaskan hubungan interaksi antara makhluk hidup dengan lingkungannya di kawasan Gunung Puntang.
Peserta didik mampu menyebutkan peran setiap spesies vertebrata dalam menjaga keseimbangan ekosistem hutan di kawasan Gunung Puntang.
Peserta didik dapat menganalisis dampak hilangnya satu spesies terhadap keseimbangan ekosistem di hutan Gunung Puntang.
Peserta didik dapat menjelaskan pentingnya upaya konservasi terhadap di kawasan Gunung Puntang.
Peserta didik dapat membuat poster mengenai konservasi hewan yang terdapat di kawasan Gunung Puntang.
2

(d) (e)

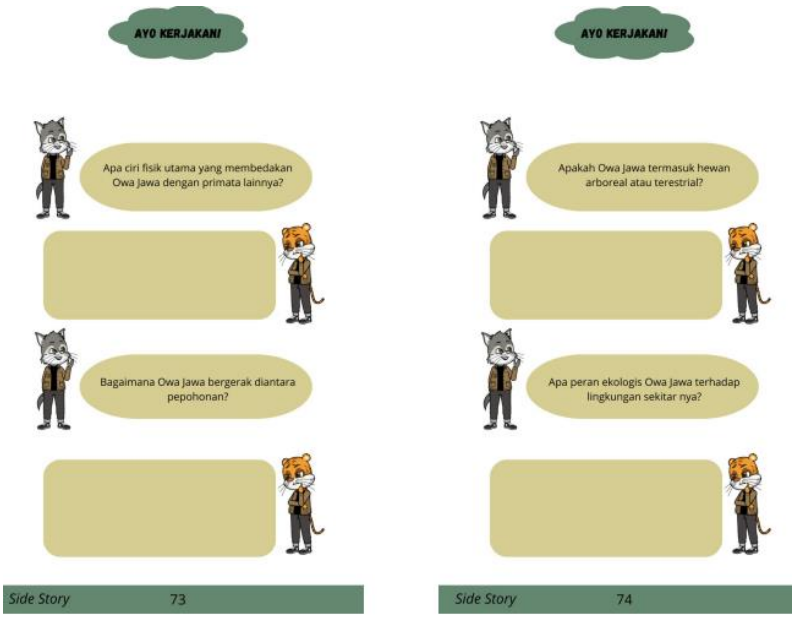

Tata cara membaca komik
Membaca komik mulai dari panel sebelah kiri ke kanan.
1
2
3
4
5
6
3


Tata cara membaca komik
Membaca balon percakapan pada komik mulai dari posisi balon percakapan yang paling atas.
Balon percakapan warna oranye berarti karakter sedang berteriak.
4


Pengenalan Karakter
Side Story
Nama : Thera
Umur : 5 tahun (setara 30 tahun-an usia manusia)
Ras : Macan
Hobi : Berpetualang
Thera
7


Pengenalan Karakter
Main Story
Nama : Andi Prayoga
Umur : 13 tahun
Ras : Manusia
Hobi : Mengamati satwa
Andi
8

(f) (g)



(h)

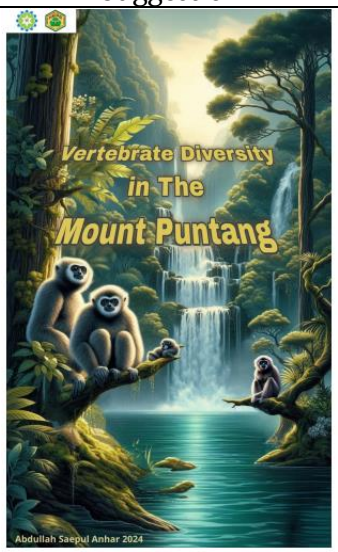
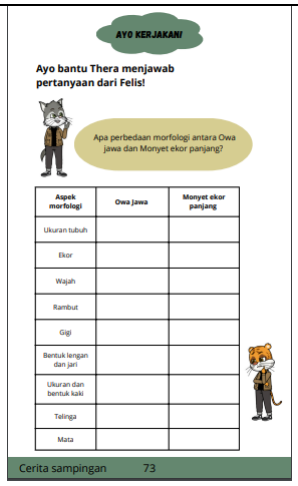
Gambar 4. Komik Prototipe 1

(a) sampul depan, (b) sampul belakang, (c) cerita sampingan, (d) cerita utama (e) CP dan TP, (f) prosedur membaca komik, (g) pengenalan karakter, (h) pertanyaan.

Develop

The development stage is the next stage of the design stage. This stage produces learning media products that are in accordance with the results of the revision based on suggestions from experts such as material experts, media experts and science subject teachers about vertebrate diversity comic media so as to produce comics that are suitable for use. Of the three validators, only from the material expert validator there was an increase. Comments and suggestions given by the material expert validator are presented in the Table as following :

Table 2. Results of Improvement by Material Experts

No.	Suggestion	Repair
1.	 Suggestions for improvement: The cover title can be in two languages or in just one language.	 Follow-up: The language in the title has been corrected to Indonesian
2.	 Suggestions for improvement: These questions are in line with learning objectives, if comparisons can be made in tabular form between one species and another.	 Follow-up: The questions have been modified to suit the learning objectives. One of the questions is made in a table format.

3.	  Side Story 72 Suggestions for improvement: For each image a source is included.	 Sumber: indonesia.go.id  Sumber: Mongabay.co.id Cerita sampingan 72 Follow-up: Each image has been accompanied by a source.
4.	**Pengenalan Karakter** **Side Story** Nama : Thera Umur : 5 tahun (setara 30 tahun-an usia manusia) Ras : Macan Hobi : Berpetualang  **Thera** 7 Suggestions for improvement: Add characters taken from adaptations of what species along with their scientific names.	**Pengenalan Karakter** **Cerita sampingan** Nama. : Thera Umur : 5 tahun (setara 30 tahun-an usia manusia) Family : Felidae Hobi : Berpetualang Adaptasi : dari spesies Panthera pardus melas  **Thera** 7 Follow-up: Species adaptations and scientific names have been added.

1. Vertebrate Diversity Validation Comic in Mountain Areas The Puntland

Table 3. Material Expert Validation

No.	Assessment Aspects	Percentage	Information
1.	Material quality	80%	Legitimate
2.	Contents	95%	Very Valid
3.	Language	90%	Very Valid
Average percentage		88%	Very Valid

Table 4. Media Expert Validation

No.	Assessment Aspects	Percentage	Information
1.	Media View	80%	Legitimate
2.	Media Content Presentation	85%	Very Valid
3.	Functions and Benefits	85%	Very Valid
Average percentage		83%	Very Valid

Table 5. Science Teacher Validation

No.	Assessment Aspects	Percentage	Information
1.	Material quality	80%	Legitimate
2.	Contents	80%	Legitimate
3.	Language	86%	Very Valid
4.	Media View	83%	Very Valid
5.	Media Content Presentation	90%	Very Valid
6.	Functions and Benefits	100%	Very Valid
Average percentage		86%	Very Valid

Table 6. Results of Overall Validator Analysis

No.	Assessment Aspects	Percentage	Information
1.	Material Expert	88%	Very Valid
2.	Media Member	83%	Very Valid
3.	Science Teacher	86%	Very Valid
Average percentage		85%	Very Valid

So that the average result of the overall validator percentage is 85% which is included in the Very valid category, because according to Riduwan & Sunarto (2019) the media that was developed can be declared feasible based on the results of expert validity with a feasibility percentage greater than score 81% with Very strong category .

2. Students' Readability of Vertebrate Diversity Comics in Mountain Areas The Puntland

Table 7. Student Readability Results

No.	Assessment Aspects	Percentage	Information
1.	Media	94%	Superior
2.	Material	84%	Superior
3.	Benefit	88%	Superior
Average percentage		88%	Superior

The results of student readability in Table 4.9 are assessed based on four aspects consisting of 12 assessment indicators, it is known that the average overall percentage is 88% which is included in the easy to understand category. As for each aspect of student readability assessment, including media, materials, and learning benefits with a percentage of 84% to 94%, with a very good category.

DISCUSSION

The product of this development research is a comic about vertebrate diversity in the Gunung Puntang area as a learning medium based on the analysis of vertebrate composition in the Gunung Puntang forest area, Bandung Regency, towards biodiversity material in MTS class VII Nurrohmah 2 Cimaung, Bandung Regency. In its development, the development stages were carried out on comic media. In developing the video, the Research and Development (R&D) method was used with a research design developed by Thiagarajan (1974) consisting of *Define*, *Design* and *Development*.

There are three validators in the development of vertebrate diversity comics in the Gunung Puntang area, namely material experts, media experts, and science subject teachers. Material validation is carried out by material expert lecturers with three aspects consisting of 13 assessment indicators. This expert material validation is carried out in order to evaluate the content of the material and the accuracy of the information presented in the learning media. According to Fitri and Ardipal (2021), material validation aims to provide information input and evaluate learning materials in learning media using learning instruments in the form of expert validation questionnaires. The results of the validation of the material experts obtained a presentation of 80% in the aspect of material quality, 95% in the aspect of comic content and 90% in the aspect of language. The presentation results of each aspect of the assessment are included in the very valid category because they have an average presentation of 88%. Based on these data, it can be seen that the aspects of comic content and language show the highest scores in the validation results by material experts. Expert validators agree that the vertebrate diversity comic in the Gunung Puntang area has the feasibility of comic content whose indicators consist of the truth of the material content, the depth of the material, the clarity of the material, and the accuracy of the material that can help students understand biodiversity material more broadly. And in terms of language with indicators of conformity to language rules, clarity in providing information, effective and efficient use of language, according to Pangesti (2012) effective sentences are sentences that are clear, concise, and straightforward so that they can be easily understood by students. Then the next aspect is communicative language, accuracy of sentence structure, and easy-to-understand language that has succeeded in making comics an informative and interactive media. The Ministry of National Education (2004) stated that good learning resources are written in good language. The use of vocabulary must achieve clarity, order, accuracy of meaning, straightforward/concise scientific language. Frankness contains the meaning of an intention that can be productively accepted by other parties (Arsyad, 2016). Thus, the information conveyed by the author will be received evenly by each reader, this is intended to avoid misinformation. This is in line with Susilana and Riyana (2009) who stated that the use of simple language can easily accepted and understood by students .

Based on the results of the expert validation test, it shows an average percentage of 88% of all aspects of the assessment. These results indicate that the validity of the material is very high, because according to Riduwan and Sunarto (2019), media that are considered feasible by experts with a percentage of more than 81% are included in the very strong category. Learning media is considered valid if the analysis results are in accordance with each of the predetermined components (Suhailah et al., 2021). The results of this validation test confirm that the vertebrate diversity comic in the Gunung Puntang area has the right learning characteristics because it gets a score of 88% in the very valid category. In addition, the material in learning media must meet validity criteria, such as content that is accurate and in accordance with learning objectives (Pratiwi and Silalahi, 2021), as well as material that is easy to understand and presented effectively (Wahyuni and Ananda, 2022).

The media validation process is assessed based on the evaluation results by media experts. The media validation assessment criteria include four aspects with 21 question indicators that are compiled to determine the level of feasibility of the product being developed. Validation by media experts is carried out to ensure that each component of the media content is appropriate, good, and suitable for use in learning. According to Rohimah et al. (2020), media expert validation aims to assess whether the developed learning media product is appropriate and suitable for use in the learning process. Media assessment includes three aspects: namely display media, presentation of media content, and functions and benefits. Each component is assessed to determine the media validity of the vertebrate diversity comic in the Gunung Puntang area, because learning media must be valid in design, which means it must be visually appealing, easy to use, and appropriate for the intended audience (Ariani et al., 2022).

The results of the media expert validation obtained a presentation of 80% on the media display, 85% on the presentation of media content and its functions and benefits. From these data, it can be seen that the highest data from the media expert validation is shown in the

presentation of media content and its functions and benefits. In the presentation of media content, there are several Indians, namely the media is presented systematically, the images can clarify the material, the language used is easy to understand, and the presentation of interesting comics.

The systematic presentation of comics means that information is arranged in a structured and logical manner, making it easy to understand. Each text and image supports a coherent storyline, from opening to closing, to prevent reader confusion. This approach makes it easier for readers to follow the material gradually, increases engagement, and strengthens understanding of the message conveyed. In learning comics, images act as visual media that clarify information, make it easier to understand, and help readers connect text with illustrations. Images also increase reader appeal and memory, especially if they are designed to be interesting and relevant. Good visualizations can convey emotions, details, or actions that are difficult to explain in words, thus supporting learning success. Furthermore, Mulyati (2002) said that images/photos in learning resources function to clarify information, help memory and understanding, provide variation so that it is not boring, and beautify it to attract readers' interest. In addition, the presentation of attractive comics is important for its success as a learning medium. Interesting comics captivate readers, motivate them to read, and make it easier to understand the material. This is achieved through bright colors, unique character designs, dynamic panel layouts, interesting storylines, and natural dialogue. This is in line with research conducted by Ardianti et al. (2019) which shows that students like colorful learning media with detailed illustrations. Elements of humor, adventure, or mystery can also make the material more lively and enjoyable. This approach is not only entertaining but also helps readers remember information better, making learning more effective. This is in line with Mardiningsih's statement (2009) which states that the use of comic media, if presented well, can stimulate interest and attention, because of its nature that can make people feel happy.

In terms of function and benefits, there are indicators as a source of learning and can attract students' interest in learning. Comics have the advantage of increasing reading interest, because of their entertaining visual and story formats. With an interesting, systematic, and story-based presentation, comics can increase readers' absorption and memory of the material being studied. Based on research by Wahab et al., (2016) it was stated that in addition to reading interest, students' willingness to read is also influenced by the availability of interesting and appropriate learning resources for students, so that they can read in a happy and relaxed condition. This is because interest is one of the factors that influences learning outcomes (Slameto, 2010).

Based on the results of media validation by science subject teachers, it was concluded that the vertebrate diversity comic in the Gunung Puntang area was declared feasible without revision and ready to be used in product trials. The average percentage of the three validators was 85%, with the highest result from material validation by material experts at 88%, followed by validation by science subject teachers at 86% and media experts at 83%. These results indicate that the vertebrate diversity comic in the Gunung Puntang area was declared feasible because it had high validity. According to Riduwan and Sunarto (2019), the assessment results with a percentage range of 80% <score <100% are included in the very strong category, so that the product the suitable used as a learning medium .

The video product of plant diversity that has been validated by experts and declared valid is then tested in small groups to determine students' readability of vertebrate diversity comics in the Mount Puntang area as a learning medium. The student readability questionnaire includes three aspects of assessment, namely media, materials and learning benefits. According to Khairiyah et al. (2016) readability is a benchmark for the suitability of material in learning materials. developed reading For reader .

The results of student readability show a percentage of 94% in the media aspect, 84% in the material aspect, and 88% in the learning benefits aspect. The percentage of each aspect of student readability assessment is in the very good category. According to Kusjuriansah and Yulianto (2019), the percentage of student readability in the range of 61%-100% means it is easy to understand. The highest readability data is in the media aspect, most students agree

that the media used in learning, such as visual design, layout, and presentation of information, are very effective and easy for students to understand.

According to Ramlan et al., (2013) if the validation score obtained has a percentage of 85% -100%, it is stated with very good criteria. With the highest percentage (94%) of media aspects falling into the very good category, this shows that the overall presentation of learning, especially media, has been well designed to support the student learning process optimally. The advantages of this media aspect also show that visual presentation has succeeded in facilitating the delivery of information, especially on material that may be difficult to explain with text alone. Illustrations that support text, easy-to-read font selection, and clear storyline arrangements help students to focus and understand the contents of the material without obstacles. Effective media not only attracts students' attention but also has a positive impact on the understanding and success of the learning process. Comics uniquely combine elements of visual communication with the skills of using text and images in creative ways, making them a very effective tool for conveying popular and easy-to-understand information. (Meidyawati et al., 2018). Thus, the media aspect in learning comics plays an important role in create experience quality learning .

According to Febriana et al. (2022), the readability questionnaire can provide information on how easy or difficult a learning resource is for students to understand, which can affect their success in understanding the material. Thus, the vertebrate diversity comic in the Gunung Puntang area can be used in class real For learn material diversity life .

CONCLUSION

Research result show that comic vertebrate diversity in the region Mountain The Puntland is a valid, interesting and effective learning medium For support learning material diversity life . Based on results validation by experts materials, media experts, and science teachers, comics This to obtain average validity value by 85%, which includes in very valid category. Validation material take notes average score of 88%, which emphasizes accuracy, depth, and clarity content. Validation of media get average score of 83%, with aspect attractive presentation and illustrations attention students. Subject teacher validation science lesson notes average score of 86%, with emphasis on the benefits of media in increase interest and understanding student to material diversity life.

In addition , readability test show very good results, especially in the media aspect with score highest by 94%. This is show that visual design, layout, and flow story comic succeed support the learning process in a way effective. With thus, comics This rated worthy used as a learning medium For increase involvement students and power absorb they to material diversity life.

Study This give contribution significant in development teaching materials based on relevant local with need learning in the modern era. This comic expected can used in a way wide in the environment education For support effort preservation diversity biological through an interesting and educational approach.

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