



Biology learning resources-based research of morphology insects in Lake Tondano



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ABSTRACT

Water hyacinth is a habitat for various types of insects in Lake Tondano. Insects that live in association with water hyacinth can be developed as a medium for learning biology. The biological characteristics of insects from Lake Tondano were developed into learning media to stimulate students' interest in learning. Students in this study are very familiar with Lake Tondano because it is a place for playing and recreation. This study aims to characterize the morphology, anatomy, and ecology of insects that live in association with water hyacinth in Lake Tondano. The method applied in this research is the research and development method of the 4D model. This research was carried out in two stages: the analysis of insects' biological characteristics in Lake Tondano and the development of biological learning media resources on Kingdom Animalia High School material. The results showed that the audiovisual learning media based on the analysis of media experts was in the high category (85.85%), material expert analysis was included in the high category (88.88%). Furthermore, the assessment by the biology teacher was high (88.67%). The test results in a small group of students, the feasibility response was high (86.2%). Based on the results of this study, this learning media is feasible to be applied in biology learning in high school for Kingdom Animalia material. The use of local biodiversity for education is influential in motivating students' interest in learning.



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Introduction

Sulawesi island is a transition area of biodiversity of flora and fauna in Indonesia ([von Rintelen et al., 2017](#)). Geologically, the island of Sulawesi is not formed from the fractures of Asia or the continent of Australia ([Hadisoesilo, 2001](#)). As a transitional area, the island of Sulawesi has many endemic species of both animals and

plants. Besides many endemic species, the geographical isolation in the past caused the intraspecies and interspecies variation of plants and animals in Sulawesi to be very high. The highest morphological variations of intraspecies were found in insects ([Rotty et al., 2018](#); [Suddin et al., 2019](#); [Timah & Samuel, 2017](#)).

One of the unique ecosystems in North Sulawesi is the ecosystem of Lake Tondano. Lake Tondano has the largest natural lake in North Sulawesi has an area of 4,438 ha (Balai Penelitian Perikanan Perairan Umum, 2016). Lake Tondano has a strategic significance for North Sulawesi due to its role as a water reservoir for hydroelectric power, rice farming, water utilities, irrigation, and tourism (Hamidun et al., 2021). Lake Tondano also serves as a natural laboratory for Manado State University, which borders Tondano lake. Lake Tondano ecosystem is an important natural laboratory for biology in university, high school, and junior high school in Minahasa, North Sulawesi. Lake Tondano is generally a suitable living habitat for freshwater fish (Susanto et al., 2017). Fish that live in Tondano lake based on fisherman catch is estimated at as many as 11 species. Fish that have habitat in the Lake of Tondano were Payangka (*Ophiocara aporos*), Mujair (*Oreochromis mossambicus*), Nila (*Oreochromis niloticus*), Mas (*Cyprinus carpio*), Gurame (*Osphronemus gouramy*), Sepat (*Trichogaster trichopterus*), nilem (*Ostochilus hasselti*), betok (*Anabas testudineus*), Gabus (*Ophicepalus striatus* sp.), Catfish (*Clarias* spp.), and Tawes (*Puntius gonionotus*). Besides fish also found shrimp, mollusks, and other freshwater animals. Payangka is the most dominant fish, then mujair, and tilapia (Balai Penelitian Perikanan Perairan Umum, 2016; Susanto et al., 2017).

Besides fish, Lake is also a habitat for various types of insects. Research conducted by Kumolontang et al. (2017) reported 133 species of insects, which are associated with water hyacinth vegetation in Tondano lake. These insects belong to the family: Culicidae, Muscidae, Phoridae, Sepsidae, Drosophilidae, Apdididae, Anthomyidae, Carabidae, Dolichopodidae, Braconidae, Stratiomiidae, Ichneumonidae, Cecidomidae, Bombylidae, and Sphingidae.

The various water plants in Lake Tondano, water hyacinth is a water weed with the largest population (Kurniawan & Paramita, 2020; Wantasen & Luntungan, 2019). The ability to regenerate water hyacinth is very fast, causing water hyacinth to become a significant problem in Lake Tondano. Water hyacinth causes the covering of the Lake's water level, hampering water transport and eutrophication, causing siltation of the

Lake (Villamagna & Murphy, 2010). Exploration of insects associated with water hyacinth in Lake Tondano was carried out to develop biology learning media in high school. The use of insects as objects in biology learning is widely applied in developed countries at this time, including in the USA, Germany, England, and Japan (Sieg et al., 2018; Weaver et al., 2017). Schools are appropriate places in which to instill a willingness to behave in an environmentally friendly way.

The target school of this research is located around Lake Tondano. Some high schools are located around Lake Tondano include SMA Negeri 1 Langowan, SMA Negeri Kakas, SMA Negeri 1 Tondano and SMA Remboken. The school's biology teachers have been the guidance partners of the research team in the development of biology learning for the past five years. Based on interviews and discussions, learning media is needed for kingdom Animalia, biodiversity, and genetic material that utilizes local biodiversity. Lake Tondano is one of the biodiversity centers in Minahasa, which is located around the schools. This research is expected to provide alternative solutions to these problems

Education is a significant factor in the conservation of local natural resources. Utilization of the lake ecosystem as a source and media of learning will be very effective, raising public awareness about essential aspects of Tondano lake. Tondano lake preservation efforts, so far that is done more emphasis on the mechanical control of water hyacinth populations. Never has been utilized Tondano lake biota for learning for junior and senior high school students, which is around Lake Tondano. This research attempted to use the Lake Tondano ecosystem and its biota as a source and learning media. Biological studies of lake biota, both animals and plants, can be used as a source or medium of learning, both visual and audiovisual. The applied learning approach is the scientific approach.

In education, both the Education unit level curriculum and curriculum 2013 put the philosophy of learning inquiry as a foothold for developing all learning models (Haridza & Irving, 2017). In the 2013 curriculum, the three main learning models offered are the discovery model, problem-based learning model, and project model

(Rakhmawati et al., 2016). The three models of learning, based on the development of scientific learning students. Students are guided learning material with the learning style of scientists.

Utilizing local biodiversity in biological learning can stimulate students' interest, motivation, and attitude towards the sustainability of local natural resources (Ardan, 2016; Ardan et al., 2015). The integration of local biodiversity in biology learning helps students enjoy the process of biology learning so that learning becomes fun and challenging (Tupas, 2019). Although local biodiversity is abundant in the student environment, especially in tropical countries such as Indonesia, few teachers integrate it in biology learning (Lindemann-Matthies et al., 2009; Nusantari et al., 2020; Sriyati et al., 2021; Sunarsih et al., 2020; Yasir et al., 2020). Biological education should integrate social values, such as the attitude of preserving natural resources in students. One approach that can be taken to incorporate social values is integrating biological learning objects such as animal biodiversity into the media or biological learning resources by teachers (Chamany et al., 2008).

The utilization of Lake Tondano biota, especially insects associated with water hyacinth, is very appropriate in biology learning. The object of the study is empirical and easily observed directly by students. Students who are in school around the Lake Tondano familiar with the biota in take Tondano. The utilization of morphological studies of insects using modern microscopy instruments will further enhance students' interest in

learning biology. The results of morphological studies of insects packaged into audiovisual learning media allow students to remember biology anywhere and anytime. Audiovisual media developed can be used using Android phones, so the flexibility of student learning is getting bigger. Using the local fruit fly isolates from Minahasa, the audiovisual learning media increased interest and student learning outcomes (Sumampouw et al., 2017; Tumbel, 2018). This study is limited to insect biology associated with water hyacinth and its application in biology learning in high school. This research aims were to develop high school biology learning resources based on insect biodiversity in Lake Tondano.

Method

This study was conducted for six months. The research was conducted in two stages: the analysis of insect characteristics from Lake Tondano (Figure 1) and learning media development. Analysis of insect characteristics, including morphology, anatomy, physiology, and ecology, was carried out at the Biology Laboratory of the State University of Manado.

Tools and Materials

The tools used include sample bottle, capture net (30 cm of diameter), glass object, Minor Surgery Set (Carl Zeiss), micropipette (Eppendorf), brush, Digital 3 D Stereomicroscope Hirox KH8700 (equipped with camera and measurement software), Carl Zeiss Stereomicroscope, Nikon Digital Pro Camera (used in water), laptop, etc. Materials used include 70% technical alcohol, labels, eosin, methylene blue, and DVD.

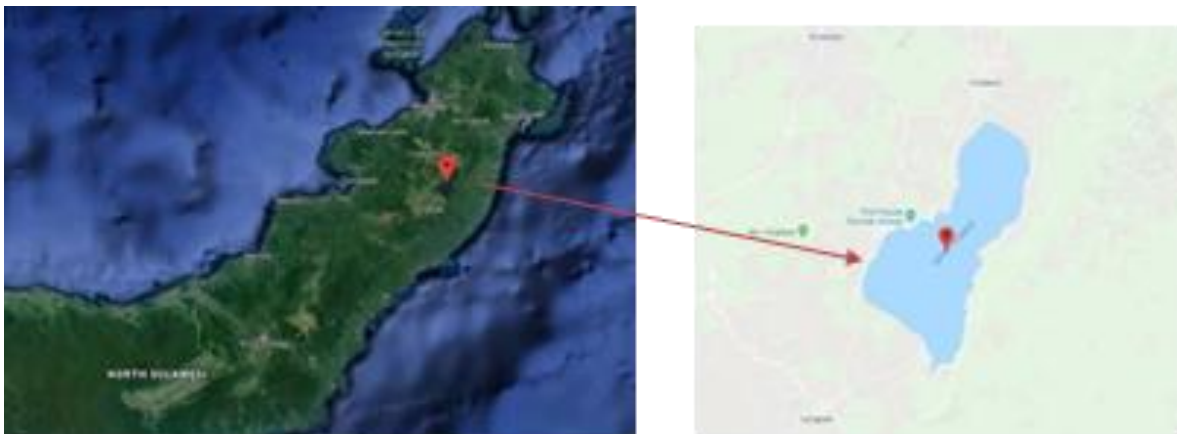


Figure 1. Lake Tondano in Minahasa, North Sulawesi (source of the map: google earth, accessed 30 June 2020).

Research methods

This research applies the descriptive method. Data of research results, obtained in field and laboratory analysis. The study consisted of 1). survey and mapping of sample sites at Lake Tondano, 2). a sampling of insects associated with water hyacinth, 3). morphological and anatomical analysis, and 4). development of biological learning materials.

Research Procedure

1. Biological studies of insects from Lake Tondano

Insects that were being observed, captured by using an insect catcher net. The captured insects were then inserted into a plastic in which there is cotton wetted with ethyl acetate. This is done to kill the insect sample. Then the insects were taken to a laboratory for species observation by microscope.

a. Morphological analysis with Carl Zeiss "Stemi DV 4" Stereomicroscope.

Qualitative morphometry data were analyzed using a microscope. Qualitative data include: body color, wing color, wing shape and venation. After the CPU is turned on, clicked on the program Stemi DV4 Carl Zeiss, then the insect sample is placed on the sample spot. Observation of morphology through a computer monitor. Magnification and lighting are set until a good image is generated on the monitor screen. This microscope is used to observe insect samples intact or not in surgery. The observed data is copied from a computer hard drive microscope.

b. Morphological analysis with a stereo microscope, three-dimensional, Hirox KH-8700 model.

The microscope is turned on, and then the object will appear directly on the monitor screen. Samples were placed on the samples plate and then set the magnification using the remote control. The microscope software will automatically set magnification. Activated the measuring program (legend and statistic) and then sample small insect body parts and insects, measured by putting a pointer using the mouse at the starting point of measurement to the endpoint. Each end of the size is captured (photographed) using a remote or mouse. The data is stored for further analysis.

c. Identification of Insects

Morphological data were used for insect identification. Identification of insects using key identification of insect

(Department of Environmental Protection, n/d; Nair et al., 2012), A Pocket Guide to Dragonflies of Peninsular Malaysia and Singapore (Orr, 2005) and digital identification dragonflies using <https://digitalatlas.cose.isu.edu>.

2. Preparation and development of biological learning media.

The development phase adopts the development model proposed by Thiagarajan et al. 1974. This development model is known as 4D. This 4D development model has four stages: Define, Design, Develop and Disseminate (Susanto et al., 2017; Trianto, 2009).

a. Define

The define phase consists of four main steps, namely: front-end analysis, student analysis, task analysis, concept analysis, and formulation of learning objectives (Trianto, 2009). At this defined stage, the initial step taken is the front-end analysis by analyzing the fundamental problems and demands of the future (Irawati & Saifuddin, 2018; Mungallamah & Saifuddin, 2021; Wurarah & Samuel, 2019). The degree to determine the potential problem is the researcher makes observations to assess the condition of the teacher and students, learning methods, media, and learning resources used. In this stage, statements were also made to support selecting appropriate media and appropriate levels of student learning. Next is analyzing student characteristics, analyzing concepts, analyzing assignments, and formulating goals (Thiagarajan et al., 1974).

b. Design

At the design stage, preproduction by designing audio visual-based learning media in learning videos. The video contains material about insects taught in high school, including anatomical and morphological structures, ecology, and DNA analysis results of some insects.

c. Develop

The development phase is carried out after passing the step of making audio visual-based learning media design in learning videos. Furthermore, existing media designs were tested on trial subjects, including material experts, learning media experts, subject teachers, and students in small groups. The trial subject will be given a rubric as an instrument of assessment of the media that has been made. From the assessment results, it will be seen the effectiveness of

the media, after which a revision will be made to improve the quality of the learning media. In the develop phase, it is also at the same time with the media evaluation stage that has been made.

d. Disseminate

The dissemination phase is carried out in small groups consisting of 10 students from three state high schools in Minahasa. Disseminate is an attempt to introduce products that have been produced more widely.

Product trials

1. Trial design

The trial design of audiovisual media-based learning media in the discussion of insects' morphology in this study can be seen in [Figure 2](#).

2. The subject of the trial

a. Material expert

The determination of the material's expert was based on several considerations, namely having a background in entomology and mastery of materials related to molecular genetics.

b. Learning media expert

The determination of learning media experts is based on several considerations:

having an educational background in learning media technology and having expertise in designing learning media.

c. Subject Teachers

The teacher who was the subject of the trial was the biology teacher at SMA Negeri Langowan, SMA Negeri Remboken and SMA Negeri Tondano. The school is located around Lake Tondano, Minahasa, North Sulawesi, Indonesia.

d. Small-Group Test

The small group test consisted of 10 students from class X Natural Sciences in three state high schools in Minahasa.

Data type

The type of data in this study is in the form of qualitative data and quantitative data. Qualitative data were obtained from material expert responses, learning media experts, subject teachers, and students in high schools included in small groups and with the results of interviews. While quantitative data obtained from the rubric assessment results were distributed to content experts, learning media experts, subject teachers, and students in state high schools in Minahasa, which are included in small groups.

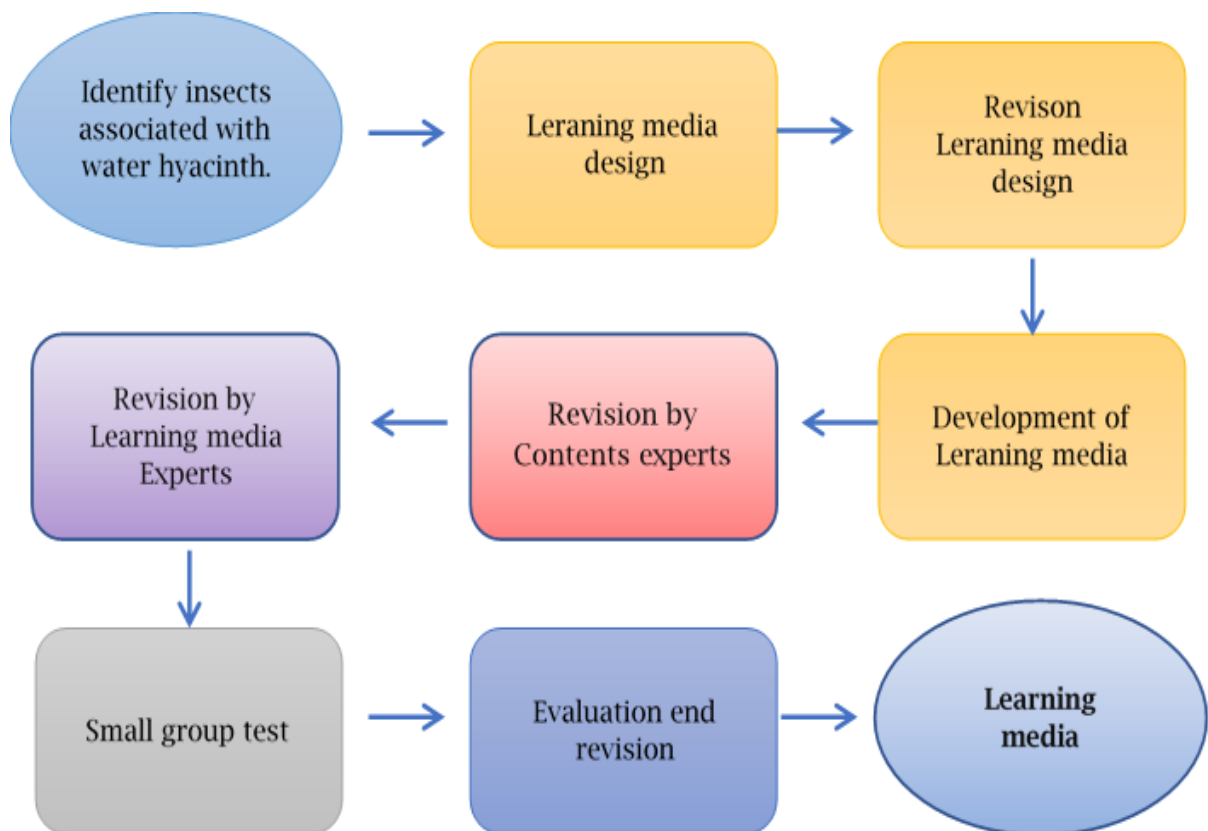


Figure 2.Product trial flow chart

Table 1. Eligibility level criteria

Level of achievement (%)	Qualification	Description
90-100	Very high	Very feasible, unnecessarily revise
75-89	High	Feasible, unnecessarily revise
65-74	High enough	Inadequate needs to be revised
55-64	Not high enough	Not feasible needs to be revised
0-54	Very not high enough	Very improper, needs to be revised

Data collection instruments.

Data collection instruments in this study were by:

1. Interview

The collected data were interviewing material experts, learning media experts, subject teachers, and students in small groups.

2. Questionnaire

The use of questionnaires in this study was used to collect quantitative data from the learning media developed. The questionnaire was given to test subjects consisting of material experts, learning media experts, subject teachers, and students in small groups.

Data analysis technique.

The data from the interview were analyzed with qualitative descriptive based on criticisms or suggestions for improvement to revise the product of audiovisual learning media. Meanwhile, quantitative data from questionnaires were analyzed using the [Formula I](#).

$$P = \frac{S}{n} \times 100\% \dots\dots\dots (I)$$

A percentage (P) overall that is obtained from a score calculated from each expert's (S) divided by the highest score of a questionnaire (N).

The results obtained from the calculation of the questionnaire assessment using the [Formula I](#) will then be matched with the eligibility or validity criteria in [Table 1](#). From this matching, it will be known whether the learning media that researchers have developed is appropriate for use or not.

Results and Discussion

The class of insects (hexapods), dominates the animal species on earth. About $\frac{3}{4}$ of animal species belong to the insect class ([Kanan et al., 2020](#)). Thus, almost all regions of planet earth will be found insects. Insect studies are extensive. The study of insects is called entomology.

The study of insects starts from the molecular aspects (genes and DNA), biochemistry, morphology, anatomy, physiology, genetics to ecology ([Sumampouw et al., 2017](#)). Thus, insects become the object of all biological studies, so it is very appropriate to be media and biology learning sources ranging from secondary education to college.

Morphological Characteristics of Insects

Seven species of insects, successfully collected from water hyacinth vegetation in the lake Tondano area. Morphological characteristics were observed in each species of the head, thorax, and abdomen. Each species of insect has variations in body color, eye color, wing color, and body morphometry (body length, thoracic length, proboscis length, legs length (femur, tibia, and tarsus), wing length, and abdominal length. Morphological characteristics observed by microscope are stored in image and video files ([Figure 3](#)).

In the morphological aspect, insects have unique characteristics compared to all animals with an exoskeleton, three pairs of legs located on each thorax segment. Wings are one of the characteristics of insects not found in other arthropods ([Weaver et al., 2017](#)). Concerning the function of insects in nature, which are also occupied by other arthropods, the introduction of bioecological features, especially the morphology of insects and their relatives, becomes very important. The introduction of morphology refers to understanding the distinctive features of a form in a group of organisms. For example, the Koksi beetle (Coccinellidae, Coleoptera) is characterized by a rounded body shape, with two front wings (elytra) clasped to form a shield. Thus, an understanding of the morphological features or form of an insect group can be used to identify or recognize the group, in addition to understanding its unique life ([Sieg et al., 2018](#)).



Figure 3. Insects associated with water hyacinth in Lake Tondano

Insects have a main character that consists of the central part of the head, thorax, and abdomen. In this study, insect morphology analysis focused on the main morphological structure. There are antennae, proboscis, compound eyes, single eyes, proboscis, and mandible in the head. In the thorax, there are three pairs of legs. Thorax consists of three segments, namely prothorax, mesothorax, and metathorax. Each segment has one pair of legs. In the metathorax, there are generally a pair of wings. The abdomen consists of 9 to 10 segments. Each species of insect associated with water hyacinth has different morphological characteristics (Appendix 1).

Factors that affect the activity of insects are the presence of water, weather, and the presence of water plants as a place to perch (Maramis & Makal, 2011; Subiono, 2019). Insects (Odonata order) are commonly found in lake and paddy ecosystems (Ward & Mill, 2005), so they have an essential role in the ecosystem. In this study, found three species were included in the order Odonata. Generally, the Odonata are classified as predators.

Insects can act as predators, both in the form of nymphs and adults and prey on different types of insects and other organisms, including rice pest insects, such as rice stalk borer (*Chilo* sp), brown planthopper (*Nilaparvata lugens*), and Walang sangit (*Laptocorisa acuta*) (Hunter, 2002; Shaalan & Canyon, 2009). In addition,

insects can serve as an indicator of ecosystem quality (Capinera, 2001; Mauricio da Rocha et al., 2010). This is because the insects have three habitats were water, land, and air. Adult female odor in oviposition selects clear and clean waters habitat, and nymphs are susceptible to polluted water quality (Shaalan & Canyon, 2009). Odonata is a group of insects that are medium to large and often attractive in color. This insect uses most of its life to fly. Insects also have a slim body with two pairs of wings and have net veins. In addition, the insects also have a short hair-shaped antenna, well-developed legs, chewing mouth type devices, large compound eyes, long and lean abdomen (Taradipha et al., 2019).

Insects have a very big role in maintaining the balance of the food chain in an ecosystem (Weaver et al., 2017). In the ecosystems it occupies, insects act as predators, thus suppressing the dynamics of the potential insect population as agricultural pests (Hunter, 2002; Williams & Williams, 2017). In addition, Kojong et al. (2015) reported that predatory insects might prey on mosquitoes, flies, and other harmful insects. Furthermore, Capinera (2001) and Mauricio da Rocha et al. (2010) state that without insects, the life of an ecosystem will be disrupted and will not achieve a balance. Ecologically insects live only in clean environments and breed around the aquatic environment (Hunter, 2002). Therefore, the presence of insects in

a domain can be used as an indication to see environmental conditions. In line with that idea, [Husseiny et al. \(2015\)](#) stated that insects could be used as a helpful water indicator to monitor water quality around the environment. Indirectly, insects' presence can indicate that there is clean water in certain neighborhoods because insects will not live on contaminated water. Therefore, changes in insect populations can be used as a first step to indicate pollution (contaminated environment).

Development of learning media

The results of insect morphology studies have been developed into high school biology learning media package. This learning media package can be used by learners as a learning resource, either directly or indirectly. The source of learning can be done by conducting field practicum activities to know the characteristics of biology, bio ecology, and insect habitat in Lake Tondano. This direct learning activity, more systematic because of the learner before field study, has had a source of learning: the morphology of insects in Lake Tondano. The insect morphological characteristics associated with water hyacinth have also been made in audiovisual learning media. Audiovisual media can be studied using a laptop or handpone android. According to the current high school biology curriculum, the prepared learning media package has been based on needs analysis.

All subject matter of biology in high school can use insects as an object of learning ([Sumampouw et al., 2017](#)). An insect morphology study was developed into 1). Practicum Guide, 2). Insectarium learning media, 3). Audiovisual learning media and reference books. This article discussed the development of audiovisual learning media. The audiovisual media created has been validated by media experts and material experts.

After making the contents of the material from this audiovisual learning media, the development stage is continued with the 4D development model, which consists of the following steps: 1) Define; 2) Design; 3) Development, and 4) Disseminate. This development model has complete stages, namely the disseminate stage, so later learning media can be used a masse. The define phase consists of

several steps, which aim together the information that underlies the need to develop audiovisual learning media at the State High School in Minahasa.

Define stage has coverage some steps, namely:

1) Front-end analysis

Front-end analysis is done by observation and interview. Observations were carried out in class X Natural Sciences in several high schools in Minahasa. Observation results showed that the learning process carried out is only in monotonous lectures and record the material in the printed book. Next, the developer interviewed the subject teacher; he explained that such a teaching process was due to the difficulty in concreting material about the morphology of animals or other material related to kingdom Animalia. He also explained that a learning medium is usually used: the PowerPoint displayed through the LCD projector, but students are less active in the learning process. The learning process in high school, especially about kingdom animalia include genetic material, is still conventional. These problems underlie the making and development of audiovisual learning media in kingdom Animalia in this high school.

2) Learner analysis

Student analysis is a study of the characteristics of students following the development of learning tools ([Thiagarajan et al., 1974](#)). Features of students in high school from learning styles found that students tend to include visual learners, i.e., students more easily understand the material if they see examples or information or lessons. Learning styles also found are auditory learners, i.e., students like to interact by discussing and communicating with others. In addition to learning techniques, high school students have exceptional technical skills. They can and are accustomed to operating computers or mobile phones, or other devices to access various information related to learning.

3) Concepts analysis

Based on the analysis of the concepts that have been carried out, the Kingdom Animalia concepts learned are as follows: Identification of insect morphology and anatomy and ecology of insects.

Table 2. Results of task analysis

Aspects	Tasks
Knowledge	(a) It understands the relationship of morphology, anatomy, and classification of insects. (b) Describe the ecological roles of insects. (c) Describe the role of insects for humans.
Social Skills	(a) Asking question (b) Raise an opinion or idea about a problem (c) Discuss opinions or ideas that have been submitted with students or other study groups
Attitude	(a) Feel happy when learning by using learning media (b) Feel happy in participating in learning biology in Audio Visual materials

4) Task analysis

Based on the results of the analysis of the tasks performed at the State High School in Minahasa in learning related to Kingdom Animalia, namely with the material details: morphology, anatomy, ecology, and insect identification, the tasks that students must do are formulated as in Table 2.

The tasks (Table 2) are applied during learning DNA material using audiovisual media in teaching videos with a scientific approach.

Formulation of purpose.

The objectives are formulated from the analysis of concepts and tasks based on competency standards and essential competencies and learning materials, and the learning objectives are as follows: a) Students can describe the relationship between the morphology and anatomy of insects; b) Students can describe the ecological role of insects; c) Students can explain the benefits of insects for humans; d) Students can sort the stages of DNA analysis for insects.

Design stage, Following the meaning of this design stage is a stage for creating content designs in audiovisual learning media and making display designs. The flow of learning media in this video consists of the opening part, the core material, and the closing. The three parts consist of sections, which can be seen in the following chart Figure 4.

Development stage, the product is developed with a feasibility/validation test, revision, and a small group trial. It is intended to produce learning media products according to needs. The feasibility and validation tests involved material experts, learning media experts, and subject teachers in this stage. They tested on a small group of 10 students from class X Natural Sciences in the Public High Schools in Minahasa.

Disseminate stage, this dissemination stage is carried out in several ways, distributed directly to students in small groups. The learning video is uploaded to youtube.com to be accessed quickly and produced through a DVD.

Study of audiovisual learning media products

The product of this learning media development is audiovisual media in the form of instructional videos. This video can be used practically because it can be stored in students' gadgets to study anywhere and anytime. If the teacher presented about "theory" make students bored because teaching just using format reading text. But in this product the theories displayed more interesting because of the various transitions frame to frame and animations as presented in Figure 5. The video is equipped with back sound, narrative, and support to play in any device. This product has a duration of 25 minutes 40 seconds start from introduction, material, and closing (see Figure 4).

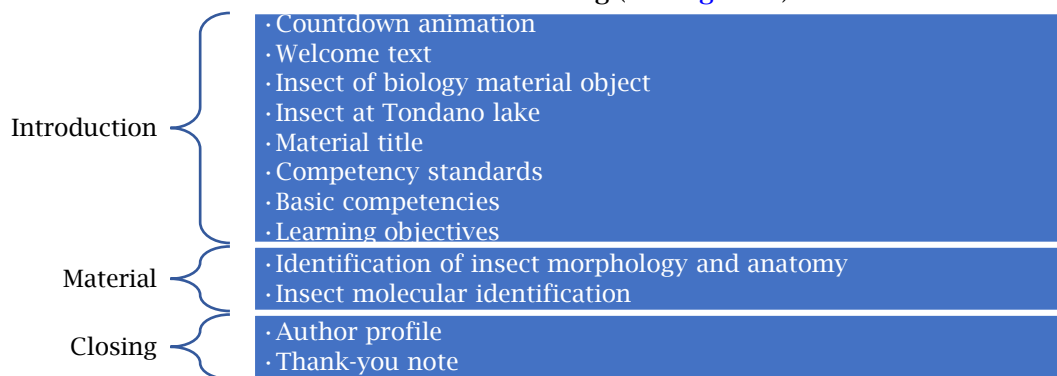


Figure 4. Learning media design chart



Figure 5. Display material presentation stages of morphology study of the insect

Analysis of product assessment results data.

This study involved four assessor subjects: material expert, learning media expert, subject teacher, and small group test consisting of 30 students of class X IPA, namely SMA Negeri Langowan, SMA Negeri Tondano, and SMA Negeri Remboken. Assessment of the product is intended to get the feasibility/validity of the learning media developed. The assessment process is carried out by filling in an assessment instrument in a questionnaire that the developer has prepared.

The assessment results from experts and subject teacher (Figure 6) showed the percentage of the product in category high (Table 1) with the description feasible, unnecessarily revised. Based on the

calculation results of the percentage assessment of the small group (Figure 6), a score of 86.2% was obtained.

The use of insects as objects of biological learning is proven to stimulate students' science skills (Sieg et al., 2018; Susilo, 2015). Furthermore, it creates fun and challenges for students (Tumbel, 2018) and fosters students' concern for conserving biological natural resources (Sumampouw et al., 2017). Morphological and bioecological studies of insects are packaged in the form of student worksheets, pocketbooks.

Students can use the audio-visual product with material-based potential Lake Tondano to learn biology in high school because the learning media developed based on ICT is very adaptive to online learning during the Covid 19 pandemic.

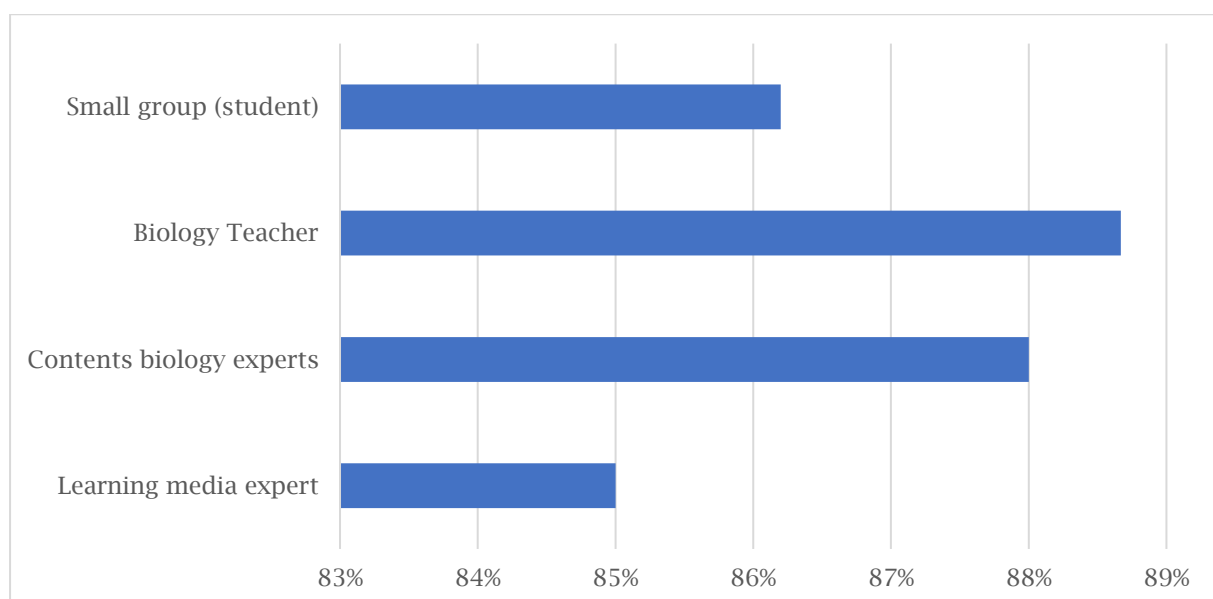


Figure 6. Assessment of material experts, media experts, teachers, and small media learning test groups.

Conclusion

They obtained seven species of insects associated with water hyacinth in Lake Tondano. The results of insect morphology analysis successfully developed into audiovisual media for biology learning. Based on the analysis results, material experts and media experts, audiovisual media-worthy applied in biology learning in high school.

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