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The Development of an Anatomy Atlas About Selected Hydrophyte and Xerophyte Structural Strategies for a Senior High School

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Abstract

This study aimed to develop an anatomy atlas about selected hydrophyte and xerophyte structural strategies as an enrichment learning medium. The Analysis, Design, Development model was used. The participants included a material expert, a media expert, biology teachers, and students of SMA Negeri 1 Wonosari at Grade XI. Data were collected using material and media expert validation sheets and questionnaires conducted with teachers and students which had been modified from other research instruments. The results were analyzed qualitatively. The anatomy atlas that was developed received favorable results, with an average value of 88.53% validity rate. Based on these results, the developed anatomy atlas would be useful for enrichment programs.

Keywords: atlas, anatomy, hydrophyte, xerophyte, enrichment

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1. Introduction

Biology learning is an interaction between teachers and learners in an academic system through good communication by involving biology objects in real and with the assistance of media [1]. The environment plays an important role in Biology learning process because it can facilitate interaction between students and learning objects [2]. Various kinds of biology objects can be found in the environment. One of the biology objects which is easily found is plants.

In the environmental perspective, plants can be characterized based on their physical traits; temperature tolerance; water supply; and their primary habitats. Plants that are characterized by water supply are the easiest plant groups to find because water is a fundamental component of life. Based on the water supply in the environment, plants are grouped into hydrophytes, xerophytes, and mesophytes [3, 4].

The very striking differences in response to the environment can be seen in the hydrophyte and xerophyte groups. Hydrophyte is group of plants that live in the waters, both plants that are completely submerged by water or only partially submerged. Meanwhile, the xerophyte is a group of plants that adapted to live in dry areas [4]. The response of plants to the environment is known as an adaptation strategy. The response of plants to the environment can be seen both macroscopically and microscopically. When viewed in terms of structure (morphological and anatomical), it is known as a structural strategy [5, 6].

Morphological aspects are closely related to anatomical structures. Furthermore, the anatomical features are clearly related to the condition of the plant habitat [6]. The relationship between anatomical structure and ecological aspects of hydrophyte and xerophyte become an interesting and comprehensive learning resource for enrichment programs.

The enrichment program is carried out to add insight with more in-depth and interesting material according to the interests of students [7]. The enrichment program provides activity which connect the class topic with facts in the environment. Students directed to get to know their environment more closely, so they are able to understand the phenomena encountered in daily life. An enrichment program is also needed to fill the spare time of students who have passed the Minimum Mastery Criterion (KKM) after the exam.

Since it is difficult for students to observe microscopic objects such as plant tissues without devices [8, 9], the hydrophyte and xerophyte structural strategies which are used as learning resources, need to be developed into media. Media can also overcome the limitations of place and time. Thus, the students can see the objects although they are not in the school. Media that suitable to show the anatomical structure is visual media such as images. An image or photo can give real-like illustration from the object, provides a more vivid and precise meaning than words, thereby stimulating the thinking skills of students [10].

One of the visual media that focuses on displaying images is atlas. To suit learning needs, the atlas is modified into a botanical atlas. Botanical atlas is a collection of complete pictures with descriptions of each type of plant [11]. This background information has driven our interest to develop an anatomy atlas in selected hydrophyte and xerophyte as enrichment media for students. Hopefully, this small study can be useful for further media innovation.

2. Related Works/Literature Review

There are some studies which are relevant to this research. Susiyawati [8], conducted a research about the difficulties learning plant anatomy. Anatomical structure cannot be seen by eyes directly. To see its structures, need some devices like microscope. But not all student can access this kind of device due to limitation of place, time, and number of devices that provided by schools.

Wildani [9] also found that students feel too much material, student's understanding are overlap between tissue in roots, stems and leaves. So, students are often confused and experienced difficulty when learning about plant anatomy. In addition, many new biological terms for students make them difficult to understand the material. Thus, it requires a media that can attract interest students to learn the material and also improve student learning outcomes.

Wulansari [12], conducted a research that aimed to produce plant diversity atlas of orders Euphorbiales, Myrtales, and Solanales that proper theoretical and empirically. Solika [13] also conducted research that aimed to produce the atlas of plants diversity in Fabales, Apocynales, and Magnoliales as the tools of identification described on the based on the theoretical and empirical studies. Usually when media is used to identification, it contains images or photos. The results showed that the product was very good for plant identification. It is showed that plant diversity atlas is suitable to use in learning activity. This atlas is expected to support biodiversity study and topic of Angiosperms. Also, the atlas can be used as teaching tool for teachers to carry out laboratory activity by direct observation about Angiosperm's plant. In other topic, Putra [14] developed atlas of Butterfly diversity in the Oyo River area as a source of biology learning and the results showed that the developed atlas is feasible as learning sources for students.

According to the research above, the hydrophyte and xerophyte structural strategies which are used as learning resources need to be developed into media to overcome the limitation. One of the visual media that focuses on displaying images is atlas. In this research, atlas was modified to suit the characteristic of hydrophyte and xerophyte anatomical structure.

3. Material & Methodology

This research was conducted in January – July 2020 using Research and Development method with ADDIE (Analysis, Design, Development, Implementation, Evaluation) Model

which was limited to the ADD phases. The Analysis phases consisted of Need Analysis, Analysis of Potential Learning Resources, Curriculum and Competency Analysis, and Instructional Analysis. While the Design phase involved Designing the Atlas Outline, Designing the Format and Systematics of the Atlas, and Designing the Atlas Feasibility Assessment Instrument. Finally, the Development phase was divided into several parts, namely Pre-Writing, Draft Writing, editing 1, Revision 1, Editing 2, and Revision 2. The subjects of this study were one material expert, one media expert, two Biology teachers, and 30 students of SMA Negeri 1 Wonosari. The object was the Anatomy Atlas in Selected Hydrophyte and Xerophyte Structural Strategies.

Qualitative data were obtained from the validation and legibility assessment. The instruments used to collect the data were material and media validation sheets, and questionnaire responses of teachers and students that have been modified from other research instruments with The Likert Scale (Very Good / Good / Not Good / Very Bad). Before main data collection, the validity and reliability of the instruments were checked by expert judgement (content validity).

Due to the pandemic COVID-19, data collection was carried out via E-mail, Google Form, and Google Drive. The data obtained then were analysed descriptively. Qualitative data obtained from experts, teachers, and student responses were converted into quantitative data in the form of a specific score. Product eligibility criteria were determined by converting the eligibility criteria into a percentage. The calculation of the percentage of the questionnaire used the following formula [15].

$$\text{Score percentage}(\%) = \frac{\text{total score}}{\text{ideal maximum score}} \times 100\%$$

The percentage of the atlas book score was then categorized under the criteria for interpretation of scores according to [16] which was described as follows: percentage 1) <21% represented very unworthy; 2) 21-40% represented less; 3) 41-60% represented enough; 4) 61-80% represented worthy; and 5) 81-100% represented very decent.

4. Results and Discussion

This research aims to develop Anatomy Atlas in Selected Hydrophyte and Xerophyte Structural Strategies and determine the feasibility of the atlas as an enrichment media. The development of this product is an innovation by looking at the potential in the field. The potentials are students' conditions and the condition of biological objects in the environment. The research phase begins by analyzing the anatomical adaptation forms of hydrophyte and xerophyte groups. The research stage is then continued with the

development of the anatomical atlas in hydrophytes and selected xerophytes structural strategies as enrichment learning media according to the results of the analysis.

4.1. Analysis

In the preparation, four types of analysis are carried out, namely needs analysis; analysis of potential learning resources; curriculum and competency analysis; as well as instructional analysis. The analysis is carried out to see how far the importance of the product to be developed and to see the potential of biological objects that can be used as enrichment media.

In need analysis, we checked out how far the urgency of anatomy atlas as enrichment media. The enrichment media is developed based on the characteristics of the material to present. In the Plant Tissue material, there are several kinds of media that can help the process of delivering the material, such as herbariums, images, or videos. The enrichment media that best represents the characteristics of plant tissue is images. Images can show anatomical structures clearly and are easily accessible to students. The plant tissue images are then compiled into an anatomical atlas as a tool for students to see plant tissue clearly anywhere and anytime.

In analysis of potential learning resources, we observed the plant samples in laboratory. We focus on the structural adaptation of hydrophytes and xerophytes to their habitat. These objects and problems can be used to find facts and concepts, so that the results of the observations meet the clarity of the potential objects. Information obtained from the results of hydrophyte and xerophyte anatomical observations is tissues in leaves, stems, or roots of hydrophytes and tissues in the xerophyte leaves. This information is phenomena that can be found in the field during the activity.

Information about hydrophyte and xerophyte plant tissues is able to enrich students' insights, since the information is deeper than the main material that has been previously presented in class. Apart from being more in-depth, the information or facts obtained reinforce the concept of plant tissue that students have obtained.

In Analysis of Curriculum and Competence, the learning resources obtained are then processed to fit the applicable curriculum and competency standards. In Permendikbud Number 24 of 2016 contains the material competency achievements of Plant Tissues material that must be achieved by students in the form of Basic Competence (KD) point 3.3 "Analysing the relation between cell structure in plant tissue and organ functions in plants".

After knowing the Core Competencies (KI) and Basic Competencies (KD), the next step is the elaboration of KD into an indicator of competency achievement and learning objectives that will be achieved by students through an anatomy atlas. Through this anatomy atlas, students can find out the types of tissues that can be found in hydrophytes and xerophytes and be able to analyse the morphological linkages, network structures in hydrophytes and xerophytes with adaptation strategies to their habitat.

Based on the analysis results, media are modified for the enrichment program. The anatomy atlas has following specifications: 1) displays a self-made image of hydrophyte and xerophyte anatomical preparations, so it is more representative of the issues focused; 2) images of preparations made by students, accompanied by images of preparations from reliable sources to make it easier for students to understand the images; 3) there is an image caption; 4) as well as a description that is able to provide a good visualization of plant tissue.

In terms of accessibility, the atlas can be used anytime and anywhere. In terms of material, the atlas is used as an enrichment learning media because the material contained is not only introducing the plant tissues but the material is more comprehensive by showing the relation between the tissue and the environmental conditions. In addition, the Indonesian version of plant anatomy atlas is still rarely developed, so that it is the advantage of the developed atlas in this study.

4.2. Design Phase

Based on the results of the analysis, then the design phase or product design is carried out which includes three phases, namely the atlas outline design, the atlas format and systematic design, and the design of the atlas feasibility assessment instrument.

The outline and format of the atlas include a cover, introduction, content and cover. The introduction contains a foreword, a table of contents, instructions for using the atlas, the characteristics and objectives of the atlas. The content section contains introductory material, images and descriptions of plant tissues, fun facts, and exploration. The closing section contains a bibliography, glossary, image index, notes, and author profile. The next design stage is the design of the atlas feasibility assessment instrument. The assessment instrument was adapted from several other instruments with changes as necessary. The instrument was also adjusted to the Assessment Standards by BSNP. The instrument contains aspects and assessment indicators with four alternative answers to see the appropriateness of the atlas in terms of material and media quality.

4.3. Development Phase

The development phase was carried out based on the two previous phases. The development phase was divided into several parts, namely pre-writing, draft writing, editing 1, revision 1, editing 2, and revision. In the pre-writing stage, reference and reliable sources were reviewed for the contents of the atlas through books, journals, the internet, and others. In this stage, the processing of learning resources that have been obtained from the analysis of potential learning resources is also carried out. Anatomical images obtained from the observations are then adjusted as needed.

The next activity was writing a draft. Draft content comes from the selection and adjustment of material at the pre-writing stage. The draft was arranged coherently and systematically so the students can easily understand the contents of the atlas using the *Corel Draw X11 software*. The draft that has been prepared then consulted with the supervisor for suggestions. The revision of draft was based on the advice of the supervisor. After the draft revision, then atlas was assessed by material experts, media experts, teachers, and students. The assessment aims to assess the feasibility of the atlas from a material and media perspective. In addition, to obtaining an assessment in the form of atlas feasibility, this assessment stage also aims to obtain suggestions for atlas improvement. Based on the results of the assessment, improvements are made. After being revised, the atlas was then tested on a limited basis to teachers and students. The results of the assessment are shown below:

Table 1: Results of the atlas assessment by material experts based on each aspect

No.	Aspect	Σ total score	Σ ideal maximum score	Index (%)	Criteria
1.	Feasibility and accuracy of the material	24	24	100	Very decent
2.	Presentation of the material	8	8	100	Very decent
3.	Evaluation	8	8	100	Very decent
4.	Language	20	20	100	Very decent
Mean				**100**	**Very decent**

The results of the assessment are analyzed qualitatively. Material experts assessed the feasibility and accuracy of the material, presentation, evaluation, and language. Assessment is carried out by one Plant Anatomy expert lecturer. Assessment by material experts showed that the anatomical atlas in the selected hydrophyte and xerophyte structural strategies was very decent for use with 100% score. Revisions are made

according to the material expert suggestions and verified with reliable sources, so the material that presented in the atlas is in accordance with the biological concepts.

Table 2: Results of the atlas assessment by media experts based on each aspect

No.	Aspect	Σ total score	Σ ideal maximum score	Index (%)	Criteria
1.	Presentation	19	24	79.17	Worthy
2.	Graphic	21	28	75	Worthy
3.	Language	8	8	100	Very decent
4.	Accessibility	15	16	93.75	Very decent
Mean				**86.98**	**Very decent**

Media experts assessed the presentation of the material, graphics, language, and accessibility of the media. Assessment carried out by the lecturer of education media shows that the anatomical atlas is very decent for use with 86,98% score. Revisions are made according to the media expert suggestions and verified with reliable sources, so the atlas can be used in the enrichment learning program.

Anatomy atlas is kind of biological atlas that has a purpose and different structure than the atlas in general, so we try to adjust the components of the atlas to fit the learning needs. The assessment results were match with [11], botanical atlas is a collection of complete pictures with descriptions of each type of plant. Learning resources or learning media should be practical, easy to obtain, flexible, fit for purpose, and can motivate its users [17, 18].

Table 3: Results of the atlas assessment by teachers based on each aspect

No.	Aspect	Σ total score	Σ ideal maximum score	Index (%)	Criteria
1.	Feasibility and accuracy of the material	42	48	87.5	Very decent
2.	Presentation of the material	18	24	75	Worthy
3.	Evaluation	12	16	75	Worthy
4.	Language	19	24	79.17	Worthy
5.	Graphic	49	56	87.5	Very decent
6.	Accessibility	28	32	87.5	Very decent
Mean				81.94	Very decent

The Biology teachers assessed the presentation of the material, evaluation, language, graphics, and accessibility of the media. The assessment is carried out by two Biology teachers at SMA Negeri 1 Wonosari. Assessment by the teachers show that the anatomy atlas is very decent for use with 81,94% score. Revisions are made according to the

teacher suggestions and verified with reliable sources, so the atlas can be used in the enrichment learning program and it is in accordance with the students' flow of thinking.

Table 4: Students' responses to the atlas based on each aspect

No	Aspect	Σ total score	Σ ideal maximum score	Index (%)	Criteria
1.	Presentation of the material	526	600	87.67	Very decent
2.	Language	287	360	79.72	Worthy
3.	Graphic	734	840	87.38	Very decent
4.	Accessibility	413	480	86.04	Very decent
Mean				**85.20**	**Very decent**

Students respond in four aspects, namely aspects of material presentation, linguistic aspects, graphic aspects, and aspects of accessibility. The responses show that the anatomical atlas was very decent for use with 85,20% score. The results of the assessment and responses are used by researchers as the last revision to improve the anatomy atlas development.

The development of this atlas certainly has research limitations. This research is only limited to the development stage so that the products that are arranged are not yet final products. To determine the effectiveness of the product, it is necessary to carry out further research, namely implementation and evaluation. In addition, the content of the material in this atlas is limited to only 9 types of plants, so it is possible to develop products into atlas with more plant species.

5. Conclusion

Based on the results of the research, it can be concluded that: 1) An Anatomy Atlas of Selected Hydrophyte and Xerophyte Structural Strategies has been developed as an Enrichment Media for Senior High School Students Grade XI, 2) The Anatomy Atlas of the Selected Hydrophytes and Xerophytes Structural Strategies as Enrichment Media are stated very decent for use based on the results of the assessment of material experts and media experts, as well as legibility tests by Biology teachers and students. The suggestion for this research is develop the anatomy atlas to learning supplementary so all of students can access it without exception; carry out further research, implementation and evaluation to determine the effectiveness of the product.

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