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The Development of Animal Physiology Textbook Based on Higher Order Thinking Skills for Biology Department Students

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ABSTRACT

The students' higher order thinking skills were still low due to the learning system, such as the use of textbooks that have not led to an increase in higher order thinking skills. The availability of updated textbooks based on higher order thinking skills was needed in the university. The aim of this study was to develop a textbook based on higher order thinking skills on animal physiology course. The development model used in this study was the Thiagarajan (4D) development model which consisted of define, design, development and dissemination. However, the research stage carried out was only up to development. The developed textbook was validated based on three criterias, namely material, language and design. The developed textbook was also tested to students who have taken animal physiology course and obtained the students' response. The result of validation by material expert was 86 in the category of "Very Good", language expert was 88 in the category of "Very Good", design expert was 87 in the category of "Very Good" and students' response according to individually, small group and limited group were 86, 89 and 89 respectively. The whole students' responses were categorized as "Very Good". It can be concluded that the product can be used as a textbook in animal physiology course. This study is useful as a learning source for students and an alternative teaching material for lecturers, as well as improving the quality of animal physiology learning.

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INTRODUCTION

Textbooks are text-based learning media that are arranged systematically for the purposes of the teaching and learning process. The use of textbooks is expected to be able to overcome student difficulties, create effective learning and maintain the quality of education by achieving learning objectives and competency attainment of graduates (Lembaga Penelitian Universitas Trisakti, 2020). Therefore, the provision of textbooks is a

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necessity in every course. One of them is animal physiology, the science that examines the interrelationships between systems and processes that occur in the animal body, as well as the relationship between animal physiology and its environment (Hasmunarti*, et al*., 2019; Probowati, *et al*., 2020).

In accordance with the Semester Learning Plan (RPS) of animal physiology, Graduate Learning Outcomes (CPL) that must be possessed by students cover the domains of attitudes, knowledge and skills. The basic thing about CPL is a good attitude and character, mastering scientific principles, as well as a skill in logical, critical, systematic and innovative thinking. These skills are closely related to the 21st-century skills needed today. In building these skills, it is necessary to carry out a learning process to an assessment process based on higher order thinking skills (Isbandiyah & Sanusi, 2019).

The higher order thinking skills of students in Indonesia are still relatively low (Isbandiyah & Sanusi, 2019). This can be seen in the low ability of students to integrate information, reason an incident and conclude solutions, formulate a real-world problem into a learning concept and conduct an investigation or finding. The higher order thinking skills of students are still low due to the learning system, such as the use of textbooks and the evaluation process that has not led to an increase in higher order thinking skills. In addition, learning difficulties are also an obstacle in the learning process, especially in material related to the basic principles of organ structure and function (Lazarowitz & Penso, 1992). This relates to the material of animal physiology.

The preliminary study was conducted by distributing questionnaires to 40 students who had taken animal physiology courses at the Biology Department, State University of Medan. The study results stated that 60% of students found it difficult to master learning animal physiology. The results of the analysis of student needs also stated that 95% of students chose textbooks as learning media that could overcome their difficulties. Therefore, the provision of textbooks is important to do in overcoming student learning difficulties (Juwita, *et al*., 2017).

The Department of Biology at the State University of Medan has not used the Animal Physiology textbook in the last two years. This is because the content of the learning material is considered insufficient by the lecturers who support the course and is not in accordance with the demands of CPL and CPMK (Course Learning Outcomes). In addition, the practice questions presented in the textbook are still limited in the ability to remember and understand or are included in the LOTS (Lower Order Thinking Skills) category.

Given the demands of the current curriculum which requires students to have higher order thinking skills, the provision of textbooks based on higher order thinking skills is very important. The results of a preliminary study on the need for Animal Physiology textbooks showed that 55% of students needed and 42.5% really needed the availability of animal physiology textbooks. The required textbooks contain new content and lead to an increase in higher order thinking skills.

Based on the problems above, the effort that can be done is by developing a textbook of animal physiology based on higher order thinking skills. The purpose of this research is to develop a textbook of animal physiology based on higher order thinking skills and to determine the feasibility level of the textbook according to material experts, linguists and design experts. This research is useful as a reference source for students and alternative teaching materials for lecturers, as well as improving the quality of animal physiology learning.

METHOD

Research Types and Subjects

This research belongs to the type of research and development using the 4-D development model (Thiagarajan, *et al*., 1974). The research was conducted at the Department of Biology, State University of Medan. The subjects in the study were undergraduate students of the Biology Education Study Program, totaling 37 students.

Research Procedure

The stages in this research include the stages of define, design and develop. At the define stage, an analysis of the problem of learning animal physiology is carried out. Students need textbooks that contain updated content and are based on higher order thinking skills.

At the design stage, the initial design of the textbook was compiled using UNESCO systematics. The textbooks are prepared based on higher order thinking skills. This is done by presenting HOTS-based assignments and practice questions.

At the development stage, a feasibility test is carried out by material experts, linguists and design experts. The next activity is product development trials. The trial was carried out on individual groups of 3 people, small groups of 9 people and limited field groups of 25 people.

Data Collection and Analysis Techniques

The data used in this study is the value of the feasibility of textbooks according to experts and the assessment of the quality of textbooks by students. The data obtained in the form of quantitative descriptive data derived from the Likert scale filling method. The answer criteria on the Likert scale are presented in Table 1.

Table 1. Answer Criteria on the Likert Scale

No	Answer	Score
1	Good	4
2	Enough	3
3	Less good	2
4	Not good	1

(Prasetiyo & Perwiraningtyas, 2017)

The data in this study were analyzed quantitatively and qualitatively. This is done by calculating the average value of the feasibility of textbooks. The results of the average eligibility scores are confirmed in Table 2.

Table 2. Eligibility Criteria for Animal Physiology Textbook

No	Scale	Eligibility Criteria
1	85 -100	Deserves a very good predicate
2	65 – 84	Deserves a good predicate
3	45 – 64	Deserves a pretty good predicate
4	0 – 44	Unfit

(Safitri & Hartati, 2016)

RESULTS AND DISCUSSION

The results of the analysis from the definition stage showed that students did not have an animal physiology textbook for the last 2 years. Through the development of this textbook, it is possible to overcome problem related to the unavailability of a textbook. Maulina & Amin (2016) stated that students can use the developed textbooks as the learning resources.The developed textbooks are needed to contextualize the material from the courses so that the material can be presented in the real terms and is able to meet the needs of students.

The development of textbooks is adjusted to the CPL and CPMK at the RPS. Expansion of the material through comparative studies, namely through comparison of physiological

mechanisms of animal groups from low to high levels. This aims to increase the complexity or completeness of the material in the textbook. Wibowo (2016) states that textbooks are written to complement or straighten things that arise from textbooks or other teaching materials. Therefore, the process of developing animal physiology textbooks needs to pay attention to the completeness and updating of information. This method can make it easier for students to understand important concepts and their applications related to animal physiology.

The design stage produces a design of animal physiology textbook based on high order thinking skills. Anderson, *et al*. (2001) stated the category of higher order thinking skills, namely the ability to analyze, evaluate and create. In this regard, the assignments and practice questions in the animal physiology textbook are arranged based on higher-order thinking skills (C4, C5 and C6). In addition, some problems become a stimulus for students to think critically in solving these problems. In line with Marada, *et al*. (2021) stated that HOTS questions are presented with a stimulus that builds critical, creative thinking skills, skilled in making decisions and solving problems.

The systematic of writing developed textbooks is in accordance to UNESCO rules (LKPP Unhas, 2015). This writing format has become a standard in the preparation of textbooks in various universities. The writing structure is adjusted to the textbook writing guidelines that are oriented towards structured and systematic knowledge transformation. In this way, textbooks can be used as a complete set of teaching materials in the process of delivering material that is in accordance with the curriculum and syllabus.

Writing textbooks is equipped with pictures, tables and reading illustrations to clarify the information conveyed. Ulandari & Syamsurizal (2021) state that the preparation of textbooks must pay attention to conformity with the level of development of students, coherence, unity of ideas and language that is easy to understand. Textbooks are also written in a communicative language. This will prevent ambiguity and misinterpretation. In the end, students do not think abstractly and easily understand learning topics.

At the development stage, a feasibility test is carried out by material experts, linguists and design experts. The results of the development stage showed that the feasibility value of the animal physiology textbook based on higher order thinking skills according to material experts was classified as very good with an average value of 86. The aspects assessed were the content feasibility, presentation and material accuracy. The value of the feasibility of the material in each aspect can be seen in Figure 1.

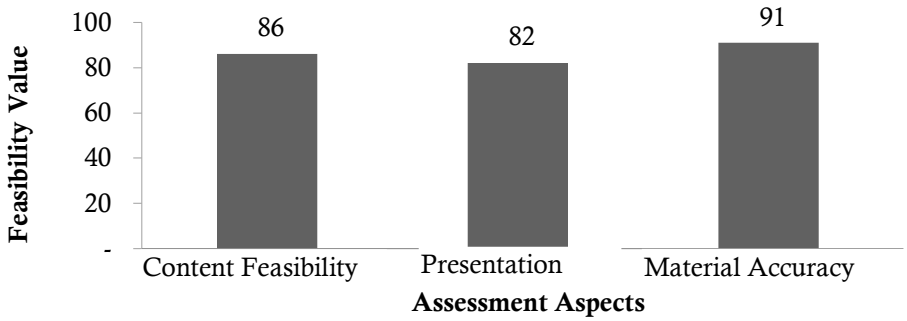

Figure 1. Graph of Feasibility Value of Animal Physiology Textbook Based on Higher Order Thinking Skills by Material Experts

The feasibility of the textbook material shows the suitability of the content of the textbook with the Courses Learning Outcomes (CPMK). In this case, the textbook developed refers to the CPMK contained in the animal physiology RPS and its relevance to the curriculum. This is in line with the research of Habibi, *et al*. (2016) which states that the preparation of textbooks is good and suitable for use in the learning process if it pays attention to the suitability of the content study with the curriculum used, relevant to learning objectives and the accuracy of the material that does not cause conceptual errors.

The presentation of the contents of the book is adjusted to the effectiveness of the presentation of the material, the systematic presentation of teaching materials from the general to the specific and the suitability of the presentation of practice questions with the material discussed. This is in accordance with what was stated by Lembaga Penelitian Universitas Trisakti (2020) that the presentation of textbooks is good when paying attention to the scientific basis and readability of the material. This relates to the arrangement of chapters in textbooks which are arranged systematically, effectively and efficiently. In addition, the presentation of words, phrases, sentences and discourse in textbooks is arranged in an organized manner.

In terms of language eligibility by linguists, animal physiology textbooks based on higher order thinking skills are generally very good with an average eligibility score of 88. The aspects assessed are communicative, straightforward, dialogical and interactive, as well as the use of terms and symbols. The value of language feasibility in each aspect of the assessment by linguist can be seen in Figure 2.

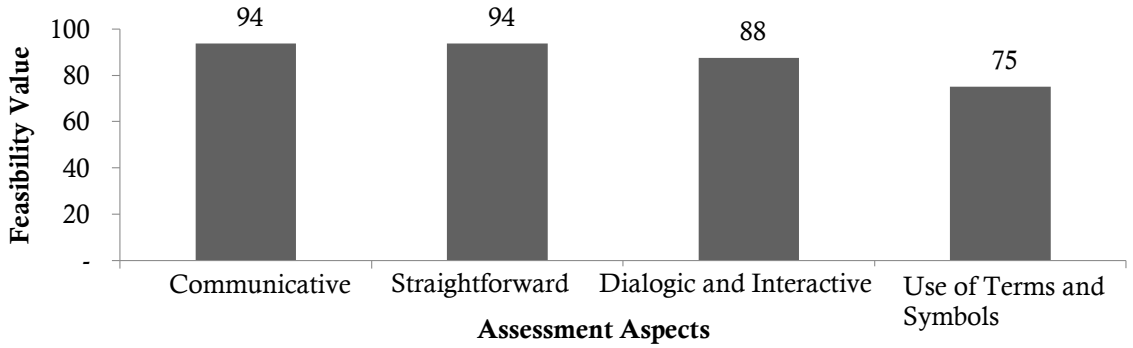

Figure 2. Graph of Feasibility Value of Animal Physiology Textbook Based on Higher Order Thinking Skills by Linguist

The level of appropriateness of the language in the communicative aspect shows the compatibility between the sentence structure and the language structure used in the textbook with the Indonesian language rules. The simplicity of the language is related to the effectiveness of choosing words to compose a sentence that does not cause double meanings. The dialogical and interactive aspects relate to the suitability of the use of language in textbooks with the level of students' abilities as readers. The assessment of the four aspects is in accordance with the communicative principle in the preparation of textbooks stated by the Lembaga Penelitian Universitas Trisakti (2020) that the material written in textbooks must be straightforward, scientific, educational, and easily understood by students. If this is fulfilled, then the textbook is

considered to have good readability and can achieve the expected learning objectives.

The feasibility value of animal physiology textbooks based on higher order thinking skills according to design experts generally is also very good with an average feasibility score of 87. Determination of the feasibility level of book design is based on four aspects, namely cover design, cover typography, content design, and content illustrations. The design feasibility value for each aspect of the assessment by design experts can be seen in Figure 3.

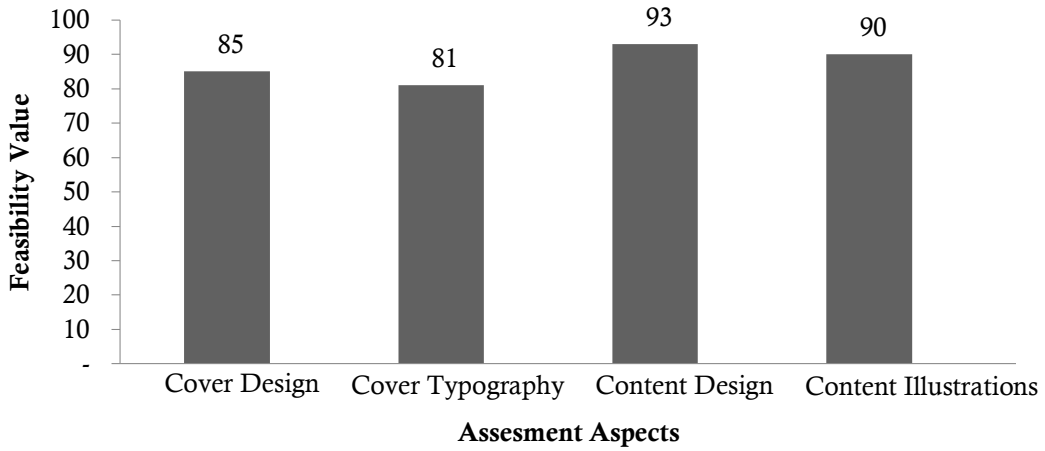

Figure 3. Graph of Feasibility Value of Animal Physiology Textbook Based on Higher Order Thinking Skills by Design Expert

Design feasibility in the content design aspect is related to image layout and image quality. The feasibility of the illustration of the contents of the book shows the suitability of the presentation of the entire illustration in the textbook that can express the meaning of the illustration well. The leather design aspect relates to the harmony of the cover layout and the suitability of the book size with the standards used. In addition, the feasibility of the design is related to the attractiveness of cover typography which can attract students' interest to read.

This is in line with what was stated by Prasetiyo & Perwiraningtyas (2017) that in the preparation of textbooks one must pay attention to book design, such as the display of images that can make it easier for readers to understand the content of the material. Therefore, the selection of image illustrations is adjusted to the content of the reading. In addition, things that must be considered are also regarding the appearance of the design of the contents and cover of the book. The design made should be as attractive as possible in order to motivate students to read the textbooks that were developed.

In the next stage, product development trials are also carried out. Students from individual groups, small groups and limited field groups give the assessments. There are 10 aspects of assessment, namely objectives suitability, material quality, sentences clarity, use of book, coherence, writing, pictures, language, evaluation and design.

In general, the individual group's assessment of textbooks is very good with an average score of 86. However, when viewed from all aspects, the clarity of sentences, writings, pictures, language, and designs are still quite good. The results of individual group assessments of the quality of textbooks can be seen in Figure 4.

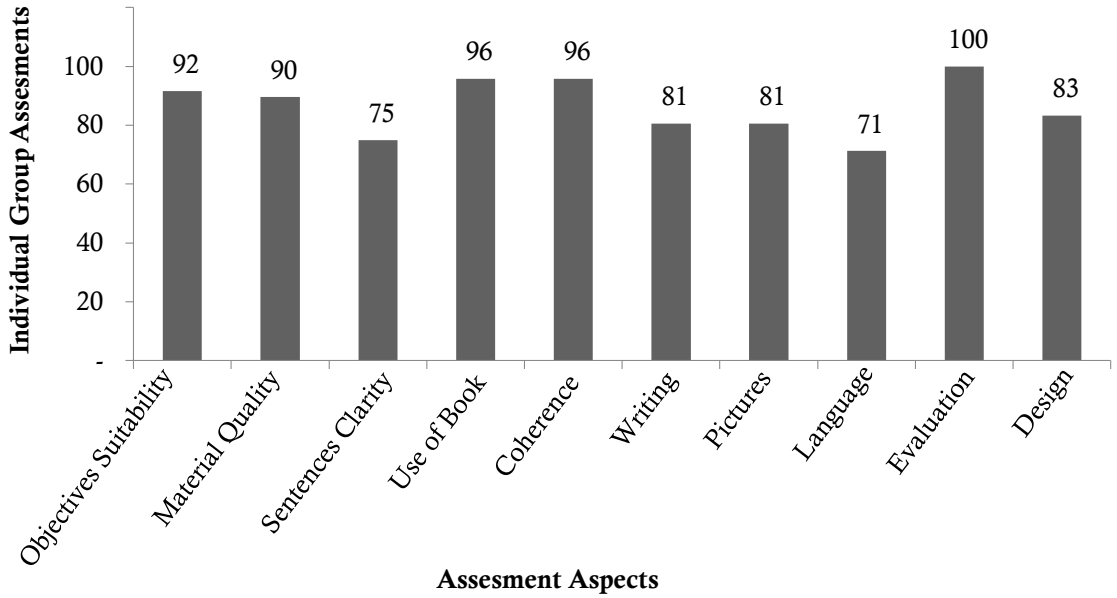

Figure 4. Graph of Individual Group Assesments to the Quality of Animal Physiology Textbook Based on Higher Order Thinking Skills

The results of the small group of students' assessments of textbooks were generally very good with an average score of 89. In terms of material quality, the pictures and language were still quite good. The results of the small group assessment can be seen in Figure 5.

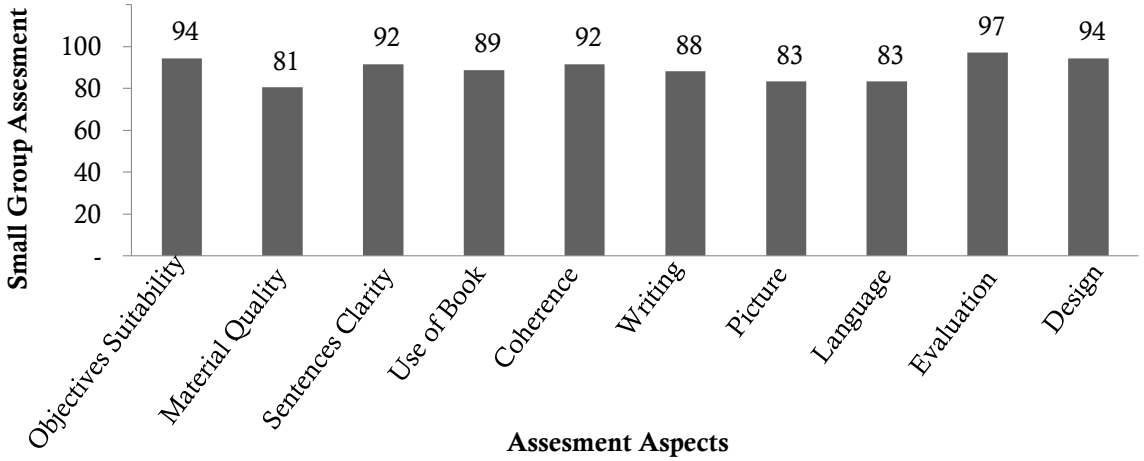

Figure 5. Graph of Small Group Assesments to the Quality of Animal Physiology Textbook Based on Higher Order Thinking Skills

At the development stage, product development trials are also carried out for limited field groups. In general, the result of the limited field group assessment of the quality of the textbook were very good with an average score of 89. However, if analyzed from the overall assessment aspect, the clarity of the sentences was still relatively good. Students are interested in the textbooks developed. The results of the assessment of the limited field group can be seen in Figure 6.

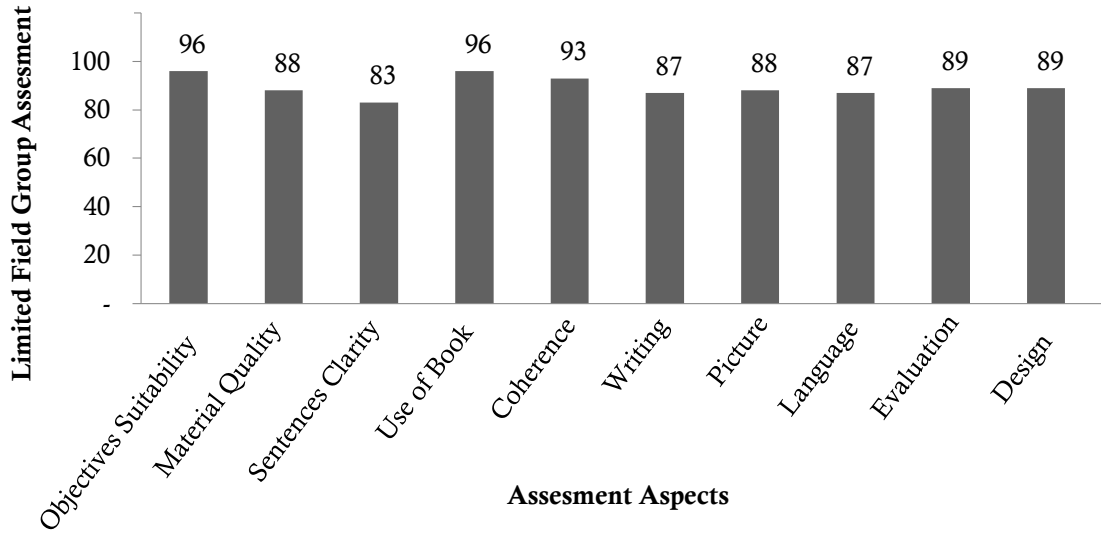

Figure 6. Graph of Limited Field Group Assesment to the Quality of Animal Physiology Textbook Based on Higher Order Thinking Skills

The student response to the animal physiology textbook based on higher-order thinking skills is very good. The results of this assessment indicate that students are interested in using the animal physiology textbook that has been developed as learning support. In addition, this textbook is considered to have a very good evaluation aspect. The practice questions in the textbooks are based on higher-order thinking skills.

This is in line with that stated by Gunada, *et al*. (2021) that one aspect of preparing a good textbook is the existence of an evaluation system that leads to higher-order thinking skills. The practice questions in the animal physiology textbook that have been developed are based on the category of higher-order thinking skills. The category is the ability to analyze, evaluate and create.

CONCLUSION

This research produces a product in the form of an animal physiology textbook based on higher-order thinking skills. The feasibility level of textbooks according to material experts, linguists, and design experts is very good. Student responses to the quality of textbooks are also very good. Animal physiology textbooks based on higher-order thinking skills are feasible and can be used as teaching materials in Animal Physiology courses.

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