

Development of Guide Book the Behavior Polinator's of Tomato (*Solanum lycopersicum*)

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Abstract- The aim of the study were to determine the quality and feasibility of guide book on behavior insecta polinator tomato (*Solanum lycopersicum*). This book development was based the Thiagarajan. Developed guidebook are validated based on the three criteria namely material/content, instructional media design and layout design. The test subjects were validated entomology experts, learning, and layout and the response of the lecturers who were lecturers of the course. The results of product validation by material experts amounted to 84% (very good), the learning design expert was 84% (very good), expert layout was 86 % (very good) and the result of students assesment showed that this guidebook was good which was value for individual assesment is 86 %, 80% for small group assesment, 82 % for limited group assesment. Thus, it could be concluded that the textbook based on research development has been feasible and could be used as the source of obtaining other information instead of students guide book.

Keywords: Field guide book, Research and development was based Thiagarajan, pollinating insects and tomato plants.

I. INTRODUCTION

Insect ecology is studied in Entomology courses. Entomology is an elective course that must be taken by students in semester V of Biology Education Department and VII semester of Biology Department at Medan State University. The basic competency achieved by students in this course is the ability of students to analyze the role of insects in ecosystems and for humans, applying classification and identification of insects. In the entomology book used by students, insect material studied includes insect structure, insect life cycle, insect identification and classification, insect ecology, the role of insects and insect collection methods [1]. The role of insects in the ecosystem studied during the learning process includes the role of insects from the negative side, so it is necessary to add material about the role of insects from the positive side.

One of the positive aspects of the role of insects is as a pollinator that affects increased agricultural production such as fruits and vegetables. This is in line with the opinion of [2] the formation of fruit and seeds in plants in general depends on the success rate of flower pollination. The declining population of pollinating insects in nature causes less than optimal fruit formation.

Tomatoes are one of the very primary agricultural products, tomatoes are now the 3rd most popular horticultural commodity after chili and shallots [3] Tomato consumption in 2016 amounted to 1.54 kg / capita / year and in 2017 consumption increased to 1.72 kg / capita / year. The highest consumption of tomatoes is achieved in 2018 which is 2.23 kg / capita / year [4] The increasing number of tomato consumption, tomato production tends to decrease in 2018 by 9.73%.

The morphology of tomato flower shape anther poricidal causes particular insect pollinators, especially those from the ordo of hymenoptera. The pollen collection mechanism is processed by inducing vibration on anther. The vibration causes pollen falling onto the body of bees and also sticking on the stigma of other tomato plants. For insects collecting pollen through a non-vibration mechanism the mechanism is to insert their probosis into the gap of anther cone of tomato flower that has previously been blown by the wind or insect pollinators. This notion is in line with the research by [5].

Insect pollinators from the same order have different behaviors in collecting pollen with different flower morphology. The shape of the flower affects the number of visits per time (foragging rate) whilst the size of the flower affects the duration of the insect visit (handling time) and the duration of pollen searching (duration buzzing) depending on the level of difficulty in yielding pollen.

Based on the observations, the understanding of Biology / Biology Education students in Unimed is still low regarding the role of insects as pollinators with 74% of the total acknowledged the importance of insect pollinators but did not understand and study it specifically, while 26% did not understand and learn the importance of insect pollinators. The difficulties stated by students were allegedly due to the lack of references regarding insect pollinators that could be used as a reference for students. Researches in recent years regarding the development of a field guide book for the introduction of insect pollinators [6,7,8,9,10] show none of the studies ever discussed the behavior of insect pollinator in pollinating plants.

A quality learning process can be sought by improving learning facilities such as the use of books as learning resources. Learning resource that open to development is field

guidebooks as supplementary books to complement the main books for students. This field guidebook contains observations of the behavior of insect pollinators on tomato plants and is equipped with student worksheets.

Through this field guidebook, students learn directly with the main source and later be trained to carry out observation, identification, data collection, data analysis, reports preparation, and reports presentation. Through these skills, it is expected that students can better understand and interpret the concepts in the entomology material, and is also presumed that students are able to design research proposals related to insect pollinators.

II. MATERIALS & METHODS

This research and development used 4-D Thiagrajan modification model [11] which comprised the step of (1) Define; (2) Design; (3) Develop; (4) Disseminate; However this study was limited simply for develop. In order to reach this purpose, the material learning tomato polinator behavior has been developed and validated by content and design experts, biology teachers review and students response or perception.

Product development was started on April 2016 and preliminary field testing was carried out on Juli 2016 to know the feasibility of product. The preliminary field testing was carried out in Universitas Negeri Medan Jalan Willem Iskandar Pasar V, Sub-District of Percut Sei Tuan, Sumatera Utara. The sample preliminary field testing was used individual, small sample, and large sample. The result were calculated using the formula [11] and category Table 1.

$$\text{Percentage} = \frac{\text{Score of assesment results}}{\text{Maximum score of assesment}} \times 100\%$$

| Interval | Category |
|----------|-----------|
| 81%-100% | Very Good |
| 61%-80% | Good |
| 41%-60% | Enough |
| 21%-40% | Less |

1. Define

a. Front-end analysis

Based on the results of an analysis conducted the need for research-based textbooks in behavior polinators in tomatos plants shown that: (a) the need for learning resources obtained 85% of students agree with the variety of learning resources; (b) interest in research-based textbooks was obtained, 74% of students expressed their agreement with the research-based textbooks for behavior polinator's of tomato (*Solanum lycopersicum*).

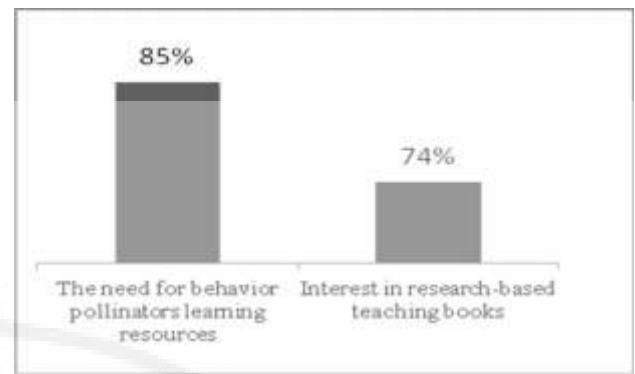


Fig. 1. The initial preliminary results and analysis of the need for teaching books based on research on multiplication of behavior polinator's of tomato (*Solanum lycopersicum*).

In the process of learning activities, students used books as learning resources. [12] states that textbooks are the type of books used in learning and teaching activities. Textbooks are arranged with flow and logic in accordance with the learning plan, according to student learning needs and to achieve specific learning goals or competencies. With the existence of textbooks, the process of teaching and learning activities will become smoother and more effective.

b. Concept Analysis

The material in the entomology course discusses insects through the introduction of morphological structures, integumentary systems, anatomy and physiology, life cycle, interactions, classification and the role of insects in human life. So it will be easier if there are learning resources that can cover all of the material that is a research-based field guidebook. The availability of this research-based field guidebook is still lacking. This is proven by the results of analysis of entomology books that link research is still low. After studying the material in entomology courses, it is known that the material being taught emphasizes more application in field study activities. The material developed is the material contained in the entomology course with the topic of behavior of pollinating insects on tomato plants (*Solanum lycopersicum*) in accordance with the learning outcomes in the entomology course. Research-based books developed in recent years discuss the introduction of pollinating insects [6,7,8,9,10]. Student learning resources about the behavior of pollinating insects in pollinating plants is still limited, students also have not maximized the full potential of learning resources to support understanding entomology material.

c. Task Analysis

The tasks that have been carried out in the Department of Biology Education Unimed are routine tasks, critical book reviews, critical journal reports, mini research, engineering ideas, projects. Completion of tasks, especially those based on research, is still rarely done. Through this field guide students are asked to observe directly so that students learn directly with the main sources in the field, then will be trained to perform scientific work steps such as observing, compiling

hypotheses, collecting data, conducting experiments, analyzing data, compiling and presenting reports. It is not only scientific skills that have increased competency in Entomology courses.

d. Formulation of Learning Objectives

The formulation of learning objectives is done by analyzing the RPS of entomology courses in the Biology department of FMIPA Unimed. The entomology textbook used by students still emphasizes the dimensions of content and the unavailability of field-based books, especially the behavior of pollinating insects on tomato plants (*Solanum lycopersicum*). The field guidebook is used to supplement the insecticidal sub-material.

2. Design

The result of these activities showed that the formatted of learning materials, the presentation component of learning material, and teaching material content. The results of these activities showed that format of learning material designed was started from determining paper size A5, font Arial size 10pt.

3. Development

The result of the product development stages was the realization of planning stage. The Draft of finishing product then validated to the expert and reviewers will gain ratings and feedback for improvements. The results of validation will help to make revision of draft product.

Draft Assessment Based on Entomology Content Expert. The results of research and development that based on entomology content expert at figure 2.

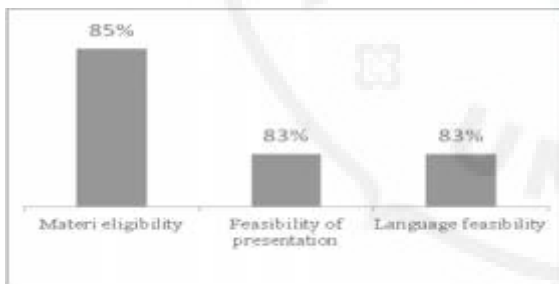


Fig 2. The graph result of Percentage on Entomology Content Expert

Figure 2 shows that the value of percentage content experts indicators was, namely: materi eligibility has 85% (very feasible) Feasibility of presentation has 83% (very feasible) Language Feasibility has 83% (very feasible). The average rating of material experts is 84% with very good criteria. The results of this assessment indicate that in terms of material, experts assess books as good and can be used in the real field as additional books in learning activities.

Draft Assessment Based on Learning Expert. The results of research and development that based on learning expert at figure 3.

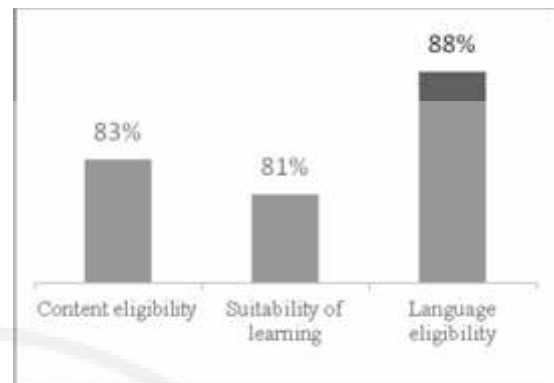


Fig 3. The graph results of research and development that based on learning expert

The results learning expert feasibility can be seen at figure 3. The results learning expert feasibility can be seen at figure 3. There are three sub-component as very feasible: learning material format, feasibility of presentation and learning systematics included in the criteria of "very good" (84%). This shows that the product has been written in the appropriate sequence and interconnected, and assisted with the use of good language.

Draft Assessment Based on Design Experts

The results of draft Assessment based on design expert can be seen in Figure 4. Figure 4 shows that the assesment of design aspect feasibility in books format, namely: books size, cover design and content design range 86 % (very feasible)

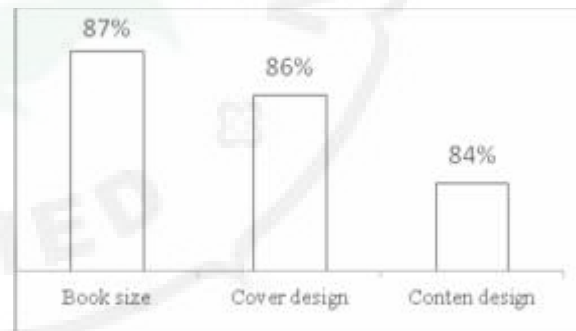


Fig 4. The results of draft assessment based on design expert

III. DISCUSSION

Based on the findings above, it shows that the feasibility in terms of material, learning and book design was very feasible as an additional book in entomology courses with a percentage of values respectively 84% (very good) and 84% (good). This is resulted due to the reference of preparation of product development to the learning objectives and the description of the material that was under the basic competency in the curriculum. Book writing systematics was valued as very good because it presented a very good coherence between sentences, paragraphs, and concepts. Besides, learning material was easier to understand because the level of the language was equal to the level of student development, clear and unambiguous phrases. The use of the Indonesia language

to convey ideas needed to be optimized [13]. The language used in learning materials must be clear, simple, and per students' abilities [14]. This book also came with glossary as a guide for understanding difficult terms. This is also in line with [15] and [16] stated that structure of learning materials is generally load titles, basic competencies to be achieved, the time required to complete, equipment or materials required to complete the task, a brief description, the work step, tasks to be performed, references and glossary.

The cover design must be in harmony and the title of the writing should be in presence. Also, it should have an adequate center of view. The images included in the designed cover must be able to describe the contents of the book material. An appropriate book should be able to motivate students by utilizing interesting features such as pictures and illustrations supporting learning [17]. The pictures presented in this book had good quality and were equipped with sketches to minimize student misconceptions about insect pollinators movements/behavior harvesting pollen. The pictures in the book can affect one's reading interest because most people look at the pictures first before reading [18]. Including pictures or sketches can provide a real description that shows real objects, provide meaningful learning and learn accurately so it arises students' thinking skills. Thus, this material might have a positive influence on learning activities, especially in increasing student motivation [19]. This is supported by the result of the 86% design validation as a very feasible category. Criteria valid with a minimum rating of > 60 [20].

This book presents the entire process and results obtained during research on the behavior of insect pollinators in collecting pollen on tomato plants and this book can be applied well. Applicative learning triggers students to build their knowledge that is easier to understand what is being learned [14]. Presentation of scientific methods, guidelines for identification and guidelines for data analysis become a guide in the process of fieldwork and the selection of mini-research assignments so that the use of this book gives an overall picture of research. It is also necessary for learners to perceive the instructional requirements to be consistent with their goals, compatible with their learning styles and connected to their past experiences. It could help students to get relevance for their learning [20, 21, 22].

Based on the evaluation of 39 students the feasibility of the material, the process of learning activities, and the use of language were very feasible. Entomology is expected to focus not merely on inculcation of concepts but opens the possibility to link theory and practice, which is building student knowledge about the surrounding environment. Through this field guide, students can learn directly with the main source.

IV. CONCLUSION

The field guidebook on the behavior of insect pollinators on tomatoes was found feasible and could be used in entomology learning based on the results of the validation of the material expert, learning design expert, layout expert with a percentage of values of 84% (very good), 84% (good) and

86 % (very good) respectively, While the responses of Biology / Biology Education students at Faculty of Mathematics and Natural Science State University of Medan on individual tests, small group tests and limited group tests, overall the categories are very good with percentages respectively 86%, 80%, and 82%.

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