



Developing the Research-Based Field Guides of Insect Pollinators on Tomato Plants

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Abstract: *To determine: (1) the feasibility and responses of material, learning design, and layout validation experts to the developed research-based field guides of insect pollinators on tomato plants; (2) the responses of the Entomology lecturer to the developed field guides of insect pollinators on tomato plants; and (3) the responses of the Biology/Biology Education students to the research-based field guides of insect pollinators on tomato plants that have been developed. The population was all the Department of Biology students, Universitas Negeri Medan, who took an Entomology course. The sample was taken by random sampling technique with the number of samples for individual groups of 3 students, small groups of 9 students, and limited groups of 21 students. The instruments were the questionnaires of field guides validation as well as students' responses to the products. The method applied the Thiagarajan 4-D development model, which consists of 4 stages: define, design, develop, and disseminate. However, this study was limited only up to the developmental stage. The results showed that: (1) the field guides were feasible and could be used in learning based on the results of the material, learning design, and layout validation scored 86%, 88%, and 93% (excellent category); (2) the field guides based on the responses of the Entomology lecturer scored 85% (excellent category); and (3) the field guides based on the responses of the students on an individual, small group and limited group tests scored 85.34%, 81.30%, and 83.18% (excellent category), consecutively.*

Keywords: *field guides, insect pollinators, tomato plants*

I. Introduction

Biology as one of the products of science has an important role in improving the quality of education, especially producing quality students who take the initiative and can find concepts in a learning process, linking these concepts into learning to face competition in the era of globalization caused by the impact of scientific developments. The development of science and technology today in people's lives requires humans to work harder to adapt to all aspects of life. One of them is the aspect of education that determines the progress and retreat of a nation's life in the midst of intense competition in the current era of globalization (Deden, 2017).

The rapid development of biology in life can have a very important impact on the development of the world of education and research related to biology. One component that is able to support this development is the use of media. In learning, there is a learning media that is used as a component in achieving learning objectives (Nuraida et al., 2017). Learning media that are very important in the world of education are divided into several types, including learning media based on technological developments, media resulting from printed technology in the form of books. In accordance with Law no. 2 of 2008 explains that books play a very important and strategic role in efforts to improve the

quality of education (Law no.2, 2008). In-Law no. 2 of 2008 Article 1 states that the books that are made can be in the form of textbooks, educator guidebooks, reference books, and enrichment books.

Ecology is a branch of biology that studies the interactions between living things and their environment. Insect ecology is studied in the Entomology course. Entomology is an elective course that must be taken by fourth-semester students at Universitas Negeri Medan. The basic competence achieved by students in this course is the ability of students to analyze the role of insects in ecosystems and, for humans, apply classification and identification of insects. In the Entomology book used by students, the insect material studied includes insect structure, insect life cycle, insect identification and classification, insect ecology, insect roles, and methods of insect collection and propagation (Manurung, 2015).

The roles of field guides in the learning process for students aim to present sources of information, study materials, and sources of activities. In addition, the field guides are also useful as a reference source of linguistic information, a source of stimulants, practicing interactive communication, ideas for a class activity, syllabus, and assistance for inexperienced teachers to grow self-confidence. Teaching materials are all forms of materials used by teachers/infrastructure in carrying out teaching and learning activities in the classroom. The material in question can be in the form of written material or unwritten material. Teaching materials as information, tools, and or texts are needed by teachers/lecturers for planning and studying the implementation of learning. Education is not only aimed at making students knowledgeable but also aims to form an attitude of discipline that leads to the realm of the field of technology, namely critical, logical, innovative, inventive, and consistent, but also accompanied by the ability to adapt (Sulistyo et al., 2016).

The development of teaching materials for field guides carried out by lecturers will provide several benefits. First, there are teaching materials that are in accordance with the curriculum and learning needs of students. Second, it is easy to obtain teaching materials because they no longer depend on other textbooks that are difficult for students to obtain. Third, there are teaching materials that are more varied and useful because they are developed according to the needs and from various references, as well as the results of the study. Fourth, contribute knowledge and experience in writing teaching materials. Fifth, build effective learning communication with students because there is a sense of pride and trust in lecturers: sixth, the fulfillment of the demands of lecturer professionalism. However, the development of teaching materials is actually not only beneficial for lecturers but also has a positive impact on students. In addition, students get the opportunity to study independently (Wulandari et al., 2017).

Based on the exposure of the data above, the researcher is interested in assessing the comparison of thyroid function in the form of FT4 and TSHs between premature babies and term infants at the first examination, which is in the age range of 2 to 6 days. It is hoped that this assessment of thyroid function can be used as the basis for further thyroid function tests, especially in premature infants. Prevention of growth disorders caused by HK in infants, especially premature infants.

The application of learning in the form of a field guide is one of the efforts made to apply skills. Based on the terminology, this field guide can be interpreted as a series of activities that support the process of acquiring knowledge (scientific products) from within students. The importance of developing a field guide helps in the learning process. Broadly speaking, it is to fill in the lack or absence of field guides contained in the Entomology course, especially for insect pollinators.

II. Research Methods

The study was conducted at the Biology Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan. The development of the research-based field guides regarding the introduction of insect pollinators on tomato plants in Karo Regency was carried out from July to September 2019. The sample was taken by random sampling technique with the number of samples for individual groups of 3 students, small groups of 9 students, and limited groups of 21 students. The instruments were the guide's validation questionnaire and students' responses questionnaire to the product. The method applied the Thiagarajan 4-D development model, which consists of 4 stages: define, design, development, and dissemination; however, this study was limited only up to the development stage.

III. Results and Discussion

3.1 Results

a. The Results of Product Development Study

The development of the field guide on the behavior of insect pollinators on tomato plants was carried out by using the Thiagarajan 4-D development model, which consists of 4 stages: define, design, develop, and disseminate.

b. The Results of the Define Stage

This stage begins with the discovery of the problems faced by the lecturer of the Entomology course. Preliminary analysis with the result that the lack of teaching materials that supports the development of information about insect pollinators, students' skills was still low because there was no practice field study in this course, so an alternative to developing learning tools based on the material in the Entomology course specifically for insect pollinators was considered. The materials taught in the Entomology course including morphology, anatomical structure, physiology, life cycle, interactions, the role of insects, methods of collection, and manufacture of insect insects. Based on the material taught, the learning objectives that will be achieved by students are formulated in the form of a supplementary book that was developed: characteristics and descriptions of insect morphology in general, descriptions of the insect pollinators morphology, factors that affect pollination by insects, methods of observing insect pollinators, types of insect pollinators on red chili plants and their characteristics, various other plants that are also visited by insect pollinators at the research location and through this guide students are expected to be able to apply research that is relevant to the research in the field guides of insect pollinators on tomato plants.

Based on the results of the needs analysis questionnaire distributed to students, it showed that 67% of students who knew the importance of insect pollinators but did not understand and study it specifically, while the remaining of 33% students mentioned that they did not understand and learn the importance of insect pollinators very well.

c. The Results of the Design Stage

At this stage, a detailed framework and program have been developed from the field guides. The stages of demonstration in this study were as follows:

1. Format of Field Guide Contents

The selection of the field guide contents of insect pollinators refers to the results of

the analysis of concepts, tasks, and analysis of learning objectives. The preparation of the field guide format begins with the identification of learning objectives that are adapted to the developed supplementary guidebook, then adjusting the learning material in the supplementary guidebook with acceptable knowledge and well-organized so that it is easy to learn.

2. Guide Draft

The draft of the guide is employed by designing the guide consists of the introduction, body, and closing pages. The preparation of the guide draft begins with determining the chapters to be presented in the book according to the learning objectives. Prior to the preparation of a field guide with the format that has been prepared, research on insect pollinators on tomato plants in Karo Regency was carried out. Various types of insects obtained in the research and also the observation process will be described in the field guide that has been developed.

Furthermore, the collection of sources related to the developed guide was carried out. These sources are taken from various books and journals related to the research topic and support the discussion in the developed guide. The writing was in accordance with the sources referring to the curriculum based on research, and it should be interesting, motivating, communicative and factual.

3. Chapter I: Introduction

This chapter discusses the process of pollination on tomato flowers of tomato and the importance of insects in life, one of which is in the agricultural sector. In this chapter, students are expected to be able to understand the importance of insect pollinators to study and attract students' desire to study it more deeply.

4. Chapter II: Insect Pollinators on Tomato Plants in Karo Regency

This chapter discusses the types of insect pollinators on tomato plants in Karo Regency, such as insect pollinators on tomato plants from the order Hymenoptera consisting of two families: the Apidae and Halictidae family. Species from the Halictidae family, including *Lasioglossum* sp. The species of Apidae are *Xylocopa iridipennis*, while the Order Diptera consists of three families: Calliphoridae of *Stomorphina discolor*, Tephritidae of *Bactrocera dorsalis*, and Syrphidae of *Syrphus ribesii*. This chapter also discusses the characteristics of insects with an exoskeleton of a hard integument or exoskeletons, which are composed of chitin and protein. The segments that make up the insect's body are divided into three parts: head (caput), chest (thorax), and stomach (abdomen). In fact, insects consist of no less than 20 segments.

5. Chapter III: Abundance, Diversity, and Evenness of Insect Pollinators

This chapter discusses the results of the author's research on the abundance, diversity, and evenness of insect pollinators on tomato plants based on the location and time of the study in Karo Regency.

6. Chapter IV: Worksheet

This chapter contains the steps of activities that make it easier for students to carry out the field studies.

7. Cover of the Field Guides

The front cover contains the identity/title of the material. The front cover is made by

depicting insect pollinators on tomato flowers in the most attractive way possible with a harmonious mix of colors.

d. Expert Validation

Validation from experts was carried out on four categories of book validity, including material, learning design, and layout validation, then the responses from the lecturers and students who take the Entomology course as well.

e. Feasibility Based on Material Validation Experts

The material validation was carried out by two experts, the components assessed are the material presented in accordance with the results in the field. The presentation technique used is able to teach students independently. The language in the field guides has a good relationship between sentences. The result of each component can be seen in the following table.

Table 1. Assessment of Material Validation Experts on the Guide Content Feasibility

Indicators	Material Experts		Score	Category
	Expert I	Expert II		
Content	82	86	84	Excellent
Presentation	84	88	86	Excellent
Language	88	88	88	Excellent
	Average		86	Excellent

Based on the result aforementioned above, the content of field guides was feasible to be developed. This was because the guide was in accordance with the facts based on the results in the field scored 84% in an excellent category.

f. Feasibility Based on Learning Design Validation Experts

The field guides on the behavior of insect pollinators on tomato plants were validated by a learning design expert. The components assessed were the feasibility of the content in accordance with the Competency Standards and Basic Competence, conformity learning can encourage students' curiosity, teaching students independently, the language in the field guides has a good relationship between sentences. The result of each component can be seen in the following table.

Table 2. Assessment of Learning Design Experts on the Entomology Course

No.	Components	Score	Category
1.	Content	86	Excellent
2.	Learning	85	Excellent
3.	Language	94	Excellent
	Average	88	Excellent

Based on the result aforementioned above, the learning design of field guides was feasible to apply for. This was because the field guide was in accordance with the Basic Competence of the Entomology course scored 84% in an excellent category.

g. Feasibility Based on Layout Design Validation Experts

The layout design validation was carried out by a lecturer named Drs. Onggal Sihite, M.Si in the Fine Arts Department, Universitas Negeri Medan. The components assessed

are the guide size according to the standard, the guide cover design should be harmonized with the title of the writing from the guides, and also have a good color combination. The layout of the images is able to clarify and facilitate understanding. The result of each component can be seen in the following table.

Table 3. Assessment of Layout Design Experts to the Field Guide Size and Design

No.	Components	Score	Category
1.	Size	92	Excellent
2.	Cover Design	93	Excellent
3.	Field Guide Design	93	Excellent
Average		93	Excellent

The mean percentage of assessments from layout design experts scored 93% and classified in an excellent category. The results showed that the field guides could be used in the actual field as an additional guidebook in learning activities. This is because the image layout is able to clarify and facilitate students' understanding.

h. Responses of the Subject Lecturers

After being validated by a team of experts both in terms of material, learning design, and layout design, the subsequent assessment was carried out to obtain responses from book readers, such as lecturers and students. The aspects of this validation are the material relevance, the use of language, and informative content.

The response of the course lecturer was carried out by a lecturer who teaches an Entomology course. The assessment was carried out to improve the quality of the field guide's appearance, and the guide presentation was eligible in supporting the learning process of the Entomology course. The results of the responses from course lecturer to field guides regarding the behavior of insect pollinators on tomato plants scored 85% in an excellent category (Table 4).

Table 4. Lecturers' Responses to the Field Guides of Insect Pollinators on Tomato Plants

Components	Score	Category
Guide View	84	Excellent
Material Presentation	87	Excellent
Average	85	Excellent

i. Small-Group Product Tests

The small group tests were carried out by nine students who had passed the Entomology course, and they were conducted to determine students' responses and assessments of learning resources and accommodate comments and suggestions to improve the quality of the field guide from the students' perspective. The small group tests were carried out by assessing three components: guide view, material presentation, and learning motivation based on 11 components including image, design, attractiveness, coherence, writing clarity, language, material quality, research component, evaluation, motivation, and information acquisition. The result of each component can be seen in the following table.

Table 6. Assessment of Small Group Tests from Students who have Taken Entomology Course

Components	Mean Score	Score	Category
Guide View	3.27	81.87	Good
Material Presentation	3.29	82.18	Excellent
Learning Motivation	3.19	79.86	Good
Average	3.25	81.30	Good

Revisions were made based on some of the respondents' suggestions, including clarifying the images presented in the field guides and adding descriptions of some insect pollinators that were deemed necessary to be added. Revisions were made by reviewing all the images and explanations presented in the guides. The average score of students' responses based on the components scored 81.30% in a good category. The results showed that after revisions were made based on student's responses, the field guides could be used in learning the Entomology course, and there was no more revision.

Table 8. Assessment of Limited Group Tests from Students who have Taken Entomology Course

Components	Mean Score	Score	Category
Guide View	3.40	85.05	Excellent
Material Presentation	3.23	80.65	Excellent
Learning Motivation	3.35	83.83	Excellent
Average	3.33	83.18	Excellent

The students' responses in individual, small group, and limited group tests to the field guides on the behavior of insect pollinators on tomato plants scored 83% in an excellent category. Based on students' responses, the field guides could be applied for learning Entomology, and there was no more revision. The result of individual, small group, and limited group product tests that have passed Entomology courses is presented in the following diagram.

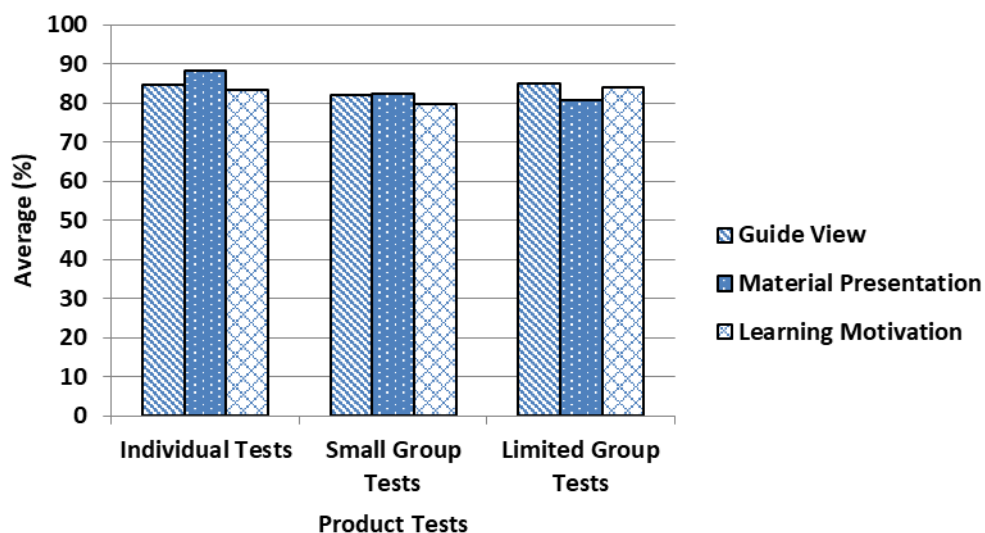


Figure 1. Students' Response Scores on Individual, Small Group and Limited Group Tests to the Field Guides

The students' responses in individual, small group, and limited group tests to the field guides on the behavior of insect pollinators on tomato plants scored 83.27% in an excellent category. Based on students' responses, the field guides could be applied for learning Entomology, and there was no more revision.

3.2 Discussion

The product that has been developed in this study is the field guides of insect pollinators on tomato plants. This guide is a supporting teaching material in studying Entomology. When analyzing the initial problem, the researcher understands that learning with teaching materials is complementary. Learning will take place effectively if it is equipped with teaching materials. One of the teaching materials is guidebooks (Permana, 2015). Learning using guidebooks can facilitate the learning process so as to help achieve student competency mastery (Syamsi, 2013).

Supplementary books are very important and strategic media in education. The reading source that has been developed is the field guides compiled based on the results of the study that has been carried out about the diversity and abundance of insect pollinators on tomato plants, and they are composed in accordance with the Guidelines for Preparation of Learning Devices and Higher Education Teaching Materials: the elements contained in the field guides, including (1) foreword, (2) table of contents, (3) body divided into chapters or sections, (4) bibliography, (5) glossary, and (6) index list (Directorate General of Learning and Student Affairs, 2017).

The developed book refers to the steps of each stage of development with the 4-D method. The author has carried out activities in accordance with the rules and steps for writing development research in accordance with predetermined limits, so that it is hoped that it will be good if applied to lectures. According to Kurniasih (2014), the provisions in making books are relevant to the goals of national education and in accordance with the abilities to be achieved. The book development process is adapted to the instructional objectives of the course, then collects various information from various library sources, such as textbooks, scientific articles, journals, and mass media, then packaged according to student needs and written as teaching materials using a systematic framework (Husamah, 2015). The ability that must be achieved in the use of field guides on tomato plants that are developed is that students are expected to be able to recognize the morphological structure of insect pollinators on tomato plants, classification of insect pollinators on tomato plants, and able to carry out the mini-research more independently.

This research-based supplementary book is expected to help students understand the concept of insects as insect pollinators and relate them to human life. According to Oktaviana (2015), research-based books have a good influence on strengthening students' understanding of abstract concepts in books for a more contextual understanding. The presentation of a book should contain examples that are close to everyday life in order to stimulate students to try or apply the knowledge they have gained in their real lives and form a transfer of learning from everything they learn from books (Rofi, 2014).

Based on the results of the study aforementioned, after several stages of revision have been carried out, it showed that in terms of material, learning and design of this field guide was very feasible to be used as an additional guidebook in Entomology course scored 86% as declared to be very suitable for the material contents, scored 88% as declared to be very suitable for the feasibility of the guide with Entomology learning and scored 93% as declared to be very proper for the feasibility of the guide size and design. The developed product that has been revised based on suggestions from the validation experts was suitable for use if the product design has received a minimum assessment in

the eligible category (Zuriyati, 2009). Valid criteria were determined if the values obtained from experts were in an excellent and good category (Trianto, 2010).

The feasibility of content was in an excellent category, scored 84%, the material presented was in an excellent category scored 86%, and the language based on a good and correct writing order was in an excellent category scored 88%. According to the validation experts, the content has been presented in a coherent, systematic, straightforward, and easy to understand. The systematic material presentation is an important aspect in the preparation of books because a coherent arrangement of the material makes it easier for students to understand the material as a whole (Prasetiyo, 2017).

The analysis of the presentation feasibility consists of three sub-components: the technique, book support section, and the learning presentation, all of them were in an excellent category with a score of 86%. This field guide was considered good to use based on its presentation because the material was presented in a coherent and easy to understand. According to Pangastuti (2016), books must be presented in a coherent and straightforward manner, the material should develop knowledge, foster motivation to think further, the material presented should develop physical activity, it is good enough to motivate students to be creative, innovative, and applicable based on the materials, tools, work stages, and content. Sentences are presented simply, with a maximum of 30 words per sentence to make it easier for readers to understand sentences (Wallwork, 2013).

Furthermore, the feasibility of language validation was also carried out by material experts with the aim of considering language structure, effectiveness, communicativeness, consistency, use of language in accordance with good and correct Indonesian and appropriately used in the preparation of research-based field guides on insect pollinators. Grammar improvement aims to make it easier for students to understand when reading these guides. After the revision of the experts, the field guide was good and suitable for use in learning scored 88% in an excellent category. According to Prastow (012), language standards including the use of good and correct Indonesian, terminology adheres to enhanced spelling, language clarity, language suitability, ease of reading, without using the same grammatical structure with multiple meanings (Wallwork, 2013). Readability is the suitability of a range for readers based on the level of difficulty or ease of discourse (Kusuma, 2018).

The learning aspect of research-based field guides was carried out by learning experts with the aim of increasing the suitability of the material discussed with the Competency Standards and Basic Competence in the Entomology course, the suitability of guides as additional teaching materials in the Entomology learning, and the appropriateness of language in accordance with good and correct writing arrangements. The results of learning design validation experts stated that the field guides in terms of content were in an excellent category scored 86% the suitability of learning including the learning systematic, and evaluation and efficiency in learning. The results of data analysis showed that the suitability of field guides for learning was in an excellent category scored 85%. This category showed that the field guides could be used in the actual field for learning activities there was no more revision. Supplementary books are considered to contain book elements and can be used in learning, such as having clear learning outcomes, motivating students to discuss, fostering curiosity and motivating students to ask questions, having clear evaluations, providing feedback for students having good and clear assessments. According to Robert, (2012), several learning activities including (1) determining learning objectives; (2) learning to ask questions; (3) familiarizing the discussion before the assessment is held; (4) reviewing, filtering, and improving; and (5) giving feedback and ratings.

The feasibility of graphics validation was assessed by layout design experts; the purpose of this validation was to assess the quality of the guide size, the guide view, the illustration of images, and the layout of the writings that make the reader interested so that students could use it as a supporting guidebook for the Entomology course. The result of layout validation scored 93% in an excellent category. This score showed that this field guide is very good for use in the learning process. This showed that this field guide had covered the criteria that any other guidebook should have for research.

The result of an assessment or data analysis from the responses of the Entomology lecturer scored 85%, which means the book could be used as an additional guidebook or a supporting book in studying insects such as insect pollinators. This can be seen from the quality of the guide view and the material presentation in supporting the learning process of the Entomology course. Based on the results of individual, small group, and limited group tests scored 84%, 82,6%, and 84%, respectively, which indicated that students were interested in reading research-based field guides. Students were interested in these guides mainly based on the content and images presented, which were considered interesting and able to increase their curiosity and motivation to read. The images in the guides work well in teaching. When text and pictures are combined, reading performance and retention are improved compared to text-only books (Hodge, 2011).

The supplementary field guides that have been developed were the results of research of insect pollinators on tomato plants conducted in Karo Regency in teaching materials for students so that students can understand the basic principles of Entomology, the development, and influence of insects on human life, which is adapted to the syllabus. This field guide is also supported by relevant theories aimed at explaining the principles of insects in general and their functions as insect pollinators. In addition, this guide also describes the design of research on insect pollinators as a material or guide for students in conducting the same field research.

Supplementary field guides that are developed would have advantages and disadvantages. The advantages of the books that have been developed are: (1) arranged systematically from general to specific by describing the introduction of insects in general and then describing insects as pollinators in particular; (2) books are compiled from research results so that students get an overview of research and its stages; (3) the field guide was developed by the author, and (4) the field guide has been validated for their feasibility and quality by material, learning design and layout validation experts. The weaknesses of this research-based field guides are; (1) the material that is described is not broad, in the sense that it cannot represent the Entomology course, (2) the images presented are the results of a private collection that may not be in the right position for taking pictures, and (3) this field guide has not been tested to see its effectiveness due to time constraints.

Limitations in developing the research-based field guides of insect pollinators on tomato plants including: (1) product tests were only carried out to a limited group test with a sample of 33 Biology students who had taken Entomology course; (2) field guides are still supported by limited sources or references; (3) the field guides have not been designed by adequate graphic arts and also have not been given an ISBN; (4) It is limited to only seeing the feasibility of the content/material based on the material, language, and learning from the experts as well as the feedback from the supporting lecturer.

IV. Conclusion

The results showed that: (1) the research-based field guides of insect pollinators on tomato plants were feasible and could be used in learning based on the results of the material, learning design, and layout validation scored 86%, 88%, and 93% in an excellent category, (2) the field guides based on the lecturer's responses in the Entomology course scored 85% in an excellent category, and (3) the research-based field guides based on the students' responses in individual, small group and limited group tests scored 85.34%, 81.30% and 83.18% in an excellent category, consecutively.

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