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Feasibility of The E-booklet Teaching Material Supplement on Fruit Fly (*Bactrocera* spp.) for High School Students on Biodiversity

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Abstract

This study aims to analyze the feasibility of fruit fly e-booklets (*Bactrocera* spp.) for grade X SMA students on biodiversity material. This study analyzes the validity, readability test, and response of e-booklets. The method used is Research & Development (R&D) with the development model used is ADDIE with three stages, namely analysis, design, and development. The feasibility of the e-booklet media used is determined based on validation from material experts and media experts. The response to the e-booklet is determined based on teacher and student responses. The readability test using the gap test was carried out in grade X. The results of the material validation got a percentage of 91.2% with a very valid category, media validation got a percentage of 91.6% with a very valid category, the readability test got a percentage of 98.7% with an independent level category, teacher responses got a percentage of 90%, and student responses got a percentage of 82% with a very good category. Based on the results of the study, it was concluded that the e-booklet media was very valid to use, positive responses were very good from teachers and students, and readability included an independent level or free which means easy to read.

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INTRODUCTION

Learning is defined as a process by which a person gains knowledge, skills, and attitudes through experience, observation, and interaction with the surrounding environment (Woolfolk, 2019). Learning as an aid provided by teachers to control the process of achieving knowledge, skills, and character and to shape attitudes and beliefs in students. Learning with direct experience involves relevant active student activities, and allows for learning through real experiences. McKinsey and Company (2021) said that research-based education can help in developing better and more effective learning methods. Zhang and Zheng (2022) also confirmed that visual representations of learning media produced from research such as scientific images are very effective in improving student understanding, especially in natural sciences, including biology. According to Baker and Hattie (2020), the benefits of learning using direct experience make students more actively involved in the learning process, which has a positive impact on motivation and interest in the subject matter. Sorden (2020) stated that the use of data and research results to create more interesting and evidence-based learning materials. Learning media based on research data is used to strengthen information in the learning process, with research results used as e-booklets to support biology learning.

Arifin (2022) explains that learning media is anything that is used as a tool to convey learning materials and help students' learning process to achieve learning goals. Learning media that function as support can be studied by students to understand the material. Students have a preference for learning media that is complete, concise, clear, and not confusing, and uses easy-to-understand language, explains difficult terms, and is equipped with pictures. The development of learning media is greatly influenced by technology, one of which is e-booklets. E-booklets are digital learning media used in the teaching and learning process. This encourages the provision of digital learning media that contain various letters, images, and graphics that can only be opened using electronic devices such as smartphones, computers, tablets, and laptops. E-booklets are arranged neatly and in detail, so that information can be understood well by students to achieve learning targets and are easier to understand. *Bactrocera* spp. is taking by using pheromone trapping which is usually used in alternative insect pest control. The pheromone trapping used in the study was by using a modified bottle using teragenol type 2. The attractant that is included in the pheromone type and is commonly used for trapping is methyl eugenol. Methyl Eugenol (ME) acts as a lure compound that has the same aroma as that of female fruit flies during mating/estrus. Fruit flies are attracted when the fruit is about to ripen which is 14-28 days after planting (generative phase), the type of fruit plant has an aroma or extraction of esters and organic acids that are fragrant when the fruit is about to ripen. Male fruit flies are attracted to methyl eugenol which acts as a "food lure" (Kardinan, 2019). Fruit flies in their bodies are able to convert methyl eugenol into a compound of pheylpropanoid and coniferyl alcohol, which in the end can function as a sex pheromone that can attract female fruit flies (Vargas et al., 2000). Methyl eugenol causes male fruit flies to fly towards the scent source and get trapped in the bottle trap, therefore.

Based on the results of interviews conducted with Biology teachers at SMA N 1 Grobogan, it was found that biology learning on biodiversity material was carried out by observing the environment around the school directly. Students are given learning media such as pictures of flora and fauna and LKPD. Biology teachers at SMA N 1 Toroh use power points equipped with LDS/LKPD, while biology learning at MAN 1 Grobogan uses textbooks and LKS. The biology learning media used in these schools are about plant diversity. Visual media (such as pictures, graphs, and videos) can improve students' understanding and memory (Mayer, 2021). Sorden (2020) also emphasized that the design of learning media can support the importance of using pictures and visuals in improving students' learning experiences. Research on the development of e-booklets on biodiversity material has been conducted. Akbar et al. (2022) showed that the Dragonfly Booklet validated by three expert lecturers in terms of content percentage of 88.89%, language percentage of 88.89%, and presentation of 94.44% in the very valid category, readability test percentage of 86.76% with a very good category. Sarip et al. (2022) stated that the biodiversity material booklet obtained results with a percentage of 85.34% with a valid category and a readability test of 90% with a very good category. Patech et al. (2022) stated that the "Echinodermata Diversity Booklet" had a validation with a percentage of 89.94% from the average of three aspects, with a very valid category. Sinaga et al. (2023) noted the response of students to the biodiversity material e-booklet media as learning with a percentage of 82.9% with a very good percentage, and the response from biology teachers with a percentage of 100% and concluded very good. Febriyanto and Anggraito (2023) noted that the "Curug Winong Diversity E-booklet" received 83.90% response from students. Zahro

(2024) stated that the e-booklet on biodiversity in moss plants on a small scale received a percentage of 83.6% with a practical category and a large scale percentage of 85.29% with a very practical category.

E-booklets are intended as supplementary teaching materials in learning biodiversity material, especially in animals. This e-booklet does not cover the overall learning or the development of other learning methods that may be needed in a broader learning process. E-booklets function as additional tools to deepen the material, but still require support from other learning sources to cover the entirety of effective learning. E-booklets have advantages in terms of ease of access and interactivity, which can help improve students' understanding of the material being studied. Supplementary teaching materials in the form of e-booklets are expected to present information that is more interesting and easy for students to understand. Before this e-booklet is widely implemented, it is important to test its feasibility in terms of validity, readability, and response to the material presented. This study aims to test the feasibility of the fruit fly (*Bactrocera* spp.) e-booklet teaching material supplement for biodiversity material for high school students, therefore. The results of this feasibility test are expected to provide recommendations regarding the use of e-booklets as learning media that are suitable for use in learning.

RESEARCH METHODS

The research method uses the Research and Development (R&D) approach which consists of three main stages, namely analysis, design, and development. At the analysis stage, identification of needs and problems faced by students in studying biodiversity material is carried out. The design stage includes designing an e-booklet as a supplement to teaching materials using Canva in the form of a pdf file. The development stage, the e-booklet that has been designed is tested and refined based on feedback from experts and student responses to ensure quality and suitability as a supplement to teaching materials.

Validity

Validity is a statement, not a behavior that is reflected in the scores obtained by the assessment instrument. Validation is carried out by three material experts and three media experts. Answers using Likert numbers with four categories, namely number 1 means not good, number 2 means less good, number 3 means good, and number 4 means very good. The formula for calculating validity test data for experts according to Akbar (2013) is as follows.

$$V = \frac{TSe}{TSh} \text{ x } 100\%$$

Description:
V : Validity
TSe : Total score from validator
TSh : Total maximum expected score

The results of the validity calculation with a known percentage can be matched with the criteria according to Akbar (2013), as follows.

Table 1. Percentage of Validation by Material and Media Experts

No.	Percentage	Validity category	Description
1.	85 < persentase ≤ 100	Very valid	Very good to use
2.	70 < persentase ≤ 85	Valid	Can be used with revisions
3.	55 < persentase ≤ 70	Quite valid	Can be used with revisions
4.	40 < persentase ≤ 55	Less valid	Must not be used
5.	25 < persentase ≤ 40	No valid	Cannot be used

Readability Test

A readability test (cloze test) is one of the assessment techniques used to assess a person's level of understanding of a text. The readability test uses a gap test where the raw data results are obtained in the form of short entries. However, this raw data is actually binary data that can be determined true/false. The product readability score is obtained through the equation:

$$\text{Score}=\frac{Number\ of\ correct\ answer}{Number\ of\ missing\ parts}\times 100\%$$

Table 2. Readability Test Value Criteria According to Rankin and Culhane (1969)

No.	Score	Readability Criteria	Interpretation
1.	60 < Persentase ≤ 100	Elevated	*Independent level*
2.	40 < Persentase ≤ 60	Average	*Instructional level*
3.	0 < Persentase ≤ 40	Nether	*Frustrational level*

The media developed is expected to enter the independent or instructional level (Suladi, et al., 2000). The independent level means that the teaching materials can be used individually without the help of a teacher or instructor. The instructional level means that the teaching materials still require guidance from the teacher. The frustration level indicates that the teaching materials cannot be used by students, because they will have difficulty understanding them. This may require guidance from the teacher, or even encourage students to look for other reading materials.

Response

The questionnaire or questionnaire of students and teachers aims to find out the response. Questionnaires were distributed to biology teachers and students, with 20 questions each. The student response questionnaire was compiled with 5 scales, namely strongly agree (SS), agree (S), disagree (KS), disagree (TS), and strongly disagree (STS). The responses assessed were aspects of interest, material, language and format. The formula for obtaining the results of the questionnaire analysis with a descriptive percentage type by Riduwan (2004), as follows. The responses assessed are aspects of interest, material, language and format. The formula for obtaining the results of the questionnaire analysis with a descriptive percentage type by Riduwan (2004), as follows.

$$\text{P} = \frac{f}{N} \times 100\%$$

Description:
P : Percentage
F : Score obtained
N : Maximum score

After that, the response score assessment was converted in the BSNP (National Education Standards Agency) assessment referring to Table 3.

Table 3. Response Categories

No.	Score	Category
1.	79 < score ≤ 100	Very good
2.	58 < score ≤ 79	Good
3.	39 < score ≤ 58	Pretty good
4.	20 < score ≤ 39	Not good

RESULTS AND DISCUSSION

Validity

Material validation is carried out to determine the validity and deficiencies of the material presented in the developed e-booklet product. The validator provided assessments, input, and suggestions for improvements to the deficiencies in the supplementary teaching materials in the form of e-booklet about fruit flies (*Bactrocera* spp.) at the stage of validating this material.

Table 4. Material Validation Results

No.	Validator	Percentage Feasibility Aspect (%)			Average Percentage (%)
		Fill	Language	Presentation	
1.	Validator 1	95	97	96	96
2.	Validator 2	83,3	93,7	100	92,3
3.	Validator 3	86,8	90	82	85,4
Average percentage		88,4	92,7	92,7	91,2
Criteria					Very valid

The suitability of the material assessed concerns three aspects of suitability assessment, including the suitability of the content of the material, the suitability of the language, and the suitability of the presentation. The content aspect ensures that the material presented is accurate and relevant, the language ensures that the language of the material can be clearly understood by the user, and the presentation ensures that the material is presented in an interesting and easy-to-follow manner. All of these aspects must be carefully validated to ensure that the material can achieve its objectives effectively. The suitability aspect of the content of educational materials includes four parts: suitability of the material, accuracy of the material, up-to-dateness of the material, and encouraging curiosity. The suitability of the CP material includes the completeness, breadth and depth of the material, so that this e-booklet continues to develop by presenting taxonomy and biodiversity at the species level, and can be used as a complement to learning biodiversity material. The e-booklet is equipped with an explanation of complex species and dendograms. Overall, the values in the material validation aspect indicate that the e-booklet developed has good quality in terms of content, language, and presentation that is relevant as a learning medium. However, although the validation results show a high percentage, the content component aspect gets the lowest score compared to other aspects. Score of 88.4% indicates that there are several deficiencies that need to be corrected related to the substance or content of the material presented. The causes are related to the complexity of the material that is lacking in explanation in several parts, or the unclear presentation of information that can affect students' understanding, especially class X.

Material experts suggest that a review be carried out to ensure that the explanation of the diversity of *Bactrocera* spp. is clearer, more correct, accurate and easy to understand by the target readers, namely class X students. This e-booklet shows overall effectiveness, although there is still room for improvement in the content aspect, but the validation results are high in the language and presentation aspects, in terms of presenting information and using language that is easy to understand. Media validation is carried out to determine the validity and deficiencies of the media presented in the developed e-booklet product. The validator provides assessment, input, and suggestions for improvement regarding deficiencies in the teaching material supplement in the form of an e-booklet at this media validation stage. This validation stage by media experts is carried out to obtain the score results for the e-booklet which are then explained in Table 5.

Table 5. Media Validation Results

No.	Validator	Percentage Graphic Feasibility Aspect (%)
1.	Validator 1	91
2.	Validator 2	90
3.	Validator 3	96,4
	Average percentage	91,6
	Criteria	Very valid

The e-booklet teaching material supplement has been verified by media experts, namely lecturers and biology teachers, to obtain a media validity score. The e-booklet media validation obtained a percentage of 91.6% with a very valid category. Percentage shows that the e-booklet developed is very valid to provide a better understanding of the diversity of *Bactrocera* spp. Singkam and Wardhani (2024) reported that the biodiversity material booklet based on the diversity of Pterygota received validation from media experts with a percentage of 91.6% with a very good category. Wete et al. (2024) reported that the percentage of the Gastropod diversity and abundance booklet from media experts was 90.58% with a very valid category. Shofa and Sari (2023) showed that the insect material booklet received a media validation value of 91.67% with a very feasible category. The validity value obtained indicates that the media has met the eligibility standards used as a tool in the learning process.

Readability Test

A gap test is a test that periodically removes words from a text to assess its readability and difficulty level. In this case, the gap test is applied to determine the level of readability from the conceptual aspect (content or meaning). The gap test is related to the brain's work in capturing the meaning of written symbols on the fruit fly (*Bactrocera* spp.) e-booklet. The gap test is better than multiple-choice tests or other tests for assessing contextual understanding and inferential ability, as well as testing language skills (reading comprehension, vocabulary, and sentence structure) simultaneously.

This gap test was given to 34 students, who obtained an average score of 98.7%. This score is included in the independent level category, indicating that the wording and sentence structure of the e-booklet are easy to understand. Rankin and Culhane (1969) noted that students who scored above 61% showed a high level of understanding and were able to learn independently or freely (independent level). Oktaria et al. (2023) reported that the booklet on the diversity of bryophytes (Bryophyta) obtained a readability test of 96% with a very good category. Oktavian et al. (2023) analyzed the readability test on the booklet on the inventory of ferns (Pteridophyta) and obtained a percentage of 89% with a very good category. Halimah (2024) noted that the booklet on soil insects obtained a readability test result with a percentage of 90%, which means that it is suitable for use as a learning resource. The average readability test score obtained from the researchers above exceeded 61%, so the media used can be categorized as an independent level.

Response

1. Teacher Responses

Data on the results of the biology teacher's response to the e-booklet were obtained from two biology teachers who obtained very good assessment criteria based on 20 aspects of response.

Table 6. Results of Biology Teacher Responses

No.	Biology Teacher	Percentage(%)	Criteria
1.	Teacher 1	86	Very good
2.	Teacher 2	89	Very good
	Average percentage	90	Very good

The teacher response test to the e-booklet resulted in a percentage of 90% from two biology teachers, indicating that the e-booklet was very very good. This shows that the e-booklet can be used in biology learning in the classroom, because it can help to meet Learning Outcomes in biodiversity material.

The biology teacher's comments on the e-booklet were very positive and provided several inputs for improvement including page color, e-booklet cover image, and explanation of biological scientific terms. The page color used was too soft so that the images listed in the e-booklet were less contrasting on several pages, so that the color of the design was improved. The e-booklet cover image initially had a green chili plant, so that the cover was more eye-catching it was suggested to change the image of the green chili plant to a green and red chili plant, so that the front cover image was replaced. Where the red-orange color is a "warm color" used to get closer to the user. This is in accordance with Mayer (2014) who suggested that the use of color is to help make important elements (such as signs or instructions) clearer and easier to see for users, and cool colors (blue, green, or gray) are usually used for the background. The validator suggested that the explanation of biological scientific terms should be improved by increasing the use of Indonesian words, whereas previously English words were more widely used.

2. Student Responses

Data on student responses to e-booklets were obtained from 34 students in class X-1 of SMA N 1 Grobogan based on 20 aspects that received a very good rating. Teachers as users of e-booklets play an important role as a tool in the learning process, helping to explain the material in a way that is easier to understand. Students are also users of e-booklets to explore the material in a more interesting and efficient way, so that learning becomes more enjoyable and useful. The response was carried out as a further evaluation of the validation by testing the material with users to get feedback. Response from students was very positive where the infographics presented interpreted the images visually in an attractive way. Ningtyas (2020) said that infographics presented in the form of text combined with visual elements such as graphics, images, illustrations or typography, so that readers are more interested and can more easily digest the information. Teacher and student responses were used to determine the feasibility of the e-booklet on the diversity of fruit flies (*Bactrocera* spp.) used as a supplement to teaching materials for biodiversity material.

Table 7. Results of Student Responses

Siswa	S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8	S 9	S 10	S 11	S 12	S 13	S 14	S 15	S 16	S 17	S 18	S 19	S 20
P1	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	5	4
P2	4	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
P3	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	4	4
P4	5	5	4	5	5	5	4	5	4	5	5	5	5	5	5	5	5	5	5	5
P5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
P6	4	4	5	5	4	4	4	4	4	4	4	5	4	4	5	4	3	4	4	4
P7	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4
P8	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
P9	1	1	1	1	2	5	5	4	5	4	5	5	4	3	5	4	5	4	5	4
P10	4	4	4	4	5	5	4	4	4	3	3	4	4	4	4	4	4	4	4	4
P11	4	3	4	5	4	4	3	5	4	3	4	4	4	4	4	5	4	4	4	4
P12	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5
P13	4	4	5	4	4	5	4	4	3	4	3	4	3	4	4	3	4	4	3	4
P14	4	4	5	4	4	5	5	4	5	5	5	4	4	4	5	4	4	4	5	4
P15	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
P16	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5
P17	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
P18	1	3	4	5	4	4	2	1	5	3	4	4	4	4	5	4	3	4	3	4
P19	4	3	5	5	5	5	5	4	5	4	4	4	3	4	5	5	4	5	4	4
P20	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
P21	4	1	4	4	2	3	4	4	4	4	4	3	3	4	3	4	4	3	4	4
P22	4	3	4	5	5	4	5	5	3	4	4	5	4	5	3	4	3	5	4	1
P23	4	3	3	4	3	4	4	4	4	4	4	4	4	4	3	4	4	4	3	4
P24	4	5	4	4	3	4	4	5	4	4	4	4	4	3	4	4	4	4	3	4
P25	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4
P26	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
P27	4	4	3	4	3	4	3	4	4	4	3	4	4	4	4	4	4	4	4	4
P28	3	4	3	5	3	4	4	4	5	3	3	4	4	3	5	4	5	4	5	5
P29	4	4	3	4	3	4	3	4	4	4	4	4	3	4	3	3	3	4	4	4
P30	4	4	5	4	4	4	4	5	4	3	3	4	4	5	4	4	4	5	4	4
P31	4	5	1	3	1	4	4	1	4	4	3	4	5	1	3	5	4	5	4	4
P32	4	4	5	5	4	4	4	4	4	4	4	5	4	4	5	4	3	4	4	4
P33	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
P34	4	4	4	4	5	5	4	4	4	3	3	4	4	4	4	4	4	4	4	4

Comparison of teacher and student responses to the e-booklet provides insight into identifying similarities and differences in perception that can affect the effectiveness and further development of the material. Teachers and students agree on relevant material, despite differences in experience and roles in the learning process. Teachers and students generally agree that the material in the e-booklet is relevant to the learning objectives and curriculum being implemented. E-booklets that are in accordance with the topics being taught and are directly related to the concepts understood will increase the understanding and involvement of teachers and students. The development of e-booklets must consider the depth of the material that can be adjusted to the needs of teachers and students. The development of e-booklets can be more targeted by understanding the needs and expectations of each, thereby deepening understanding and improving the overall learning experience.

CONCLUSION

Based on the research results, it was found that the validity of the fruit fly e-booklet (*Bactrocera* spp.) in material validation obtained a percentage of 91.2% with a very valid category and media validation obtained a percentage of 91.6% with a very valid category. The e-booklet readability test obtained a percentage of 98.7% with an independent level category. Teacher responses to the e-booklet obtained a percentage of 90% and student responses obtained a percentage

of 82% with a very good category. Referring to these various considerations, the e-booklet is considered suitable for use as a supplement to teaching materials.

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