



Development of SMART E-Encyclopedia Based on Lepidoptera Diversity in Ndodang Forest as Biology Learning Resource

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Abstract: This study aims to develop a practical and user-friendly SMART E-Encyclopedia of Lepidoptera diversity as a biology learning resource for Class X Students. This research was a Research and Development (R&D) research using the Borg and Gall development model. This research was only carried out for eight stages with the following steps: (a) potential problem, (b). data collection, (c) designing the template on Canva, (d) preparing the draft, (e) uploading the product on the flipbook, (f) validation, (g) revision according to the suggestion of the validator, and (h) uploading the revised product to the flipbook platform. Lepidoptera diversity was identified from March to May 2023 in Ndodang Forest, Widodaren Village, Gerih Sub-district, Ngawi Regency. The development of the SMART E-encyclopedia was conducted from May to August 2023. SMART E-Encyclopedia was subjected to validation by the material expert, media expert, and Class X biology teacher to obtain a score of 70%, 93%, and 80%, respectively. Based on the scores, the product had an average percentage of 81% and was feasible for use as a biology learning resource for Class X students. The advantages of this e-encyclopedia are (1). Explanation of broader material. (2). This E-Encyclopedia was equipped with video and many application features to make it easier for users.

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Introduction

The civilization of a nation is driven by different factors, such as quality education. Shaping education to possess 21st-century skills is a challenge for the entire educational community in Indonesia. Therefore, strong impetus and willingness are needed to build the civilization of a nation (Rahayu et al., 2022). The availability of human resources is one of the investments that consistently contribute to the development and growth of a nation. Education also equips individuals to explore and cultivate their potential to face the challenges of knowledge and technological advancements (Wibowo et al., 2018) as a significant aspect of human life (Suprpto et al., 2019).

Learning resources play a vital role in assisting students in comprehending the concepts conveyed by teachers. The objectives can be effectively communicated by developing appropriate and innovative teaching materials. The development of 21st-century skills is also influenced by teachers' competence in providing creative learning (Daga et al., 2022) and creating a more interactive classroom environment (Nurani et al., 2022). Learning resources are materials in the form of data or objects that are deliberately collected to enable independent learning for students (Hadiapurwa et al., 2021). Rapid growth drives the transformation of the education world to update and provide meaningful experiences (Rahmawati & Atmojo, 2021). Furthermore, 21st-century learning involves digital-based



enriched with images and videos (Peña-Ayala, 2021) and the provision should also be designed attractively to provide meaningful experiences (Irdalisa et al., 2023). Digital-based resources can make learning more engaging and enjoyable for students. E-Encyclopedia is one of the packaging innovations in technology-based biology learning resources that contain content in the form of information about a knowledge term. The presented material is organized alphabetically to facilitate readers in delving into the desired topics. The main benefits are providing a foundation of information, exploring knowledge, and verifying the accuracy of information on discoveries and objects. Beyond offering information through definitions, E-Encyclopedia includes images to clarify the imagination of readers. This creates a new atmosphere to facilitate students' understanding of the presented material, as E-Encyclopedia combines appealing images and well-structured texts (Julianti et al., 2021). Apart from text-based media, there are many options for learning resources, including using video media. Videos combine visual and audio elements to present information in the form of animated motion within a specific period. Adding the content to biology education can enhance learning interest and facilitate the understanding of the concept (Rahayu et al., 2020) through audio-visual media.

Ndodang forest is located in the Bangsal hamlet, Widodaren Village, Gerih Sub-district, Ngawi Regency, with the potential for flora and fauna, including teak trees (*Tectona grandis*), johar trees (*Senna siamea*), sonokeling trees (*Dalbergia latifolia*), turmeric plants, and other vegetation. There is a high diversity of birds, reptiles, and insects for fauna, particularly a diverse range of Lepidoptera species. The characteristic of varied wing colors is the origin of the term Lepidoptera in Greek, where "*lepis*" and "*ptera*" mean scales and wings.

Lepidoptera is one of the orders in the class Insecta, divided into two suborders, namely Heterocera (moths) and Rhopalocera (butterflies). Moths comprise 90% of the total species, while butterflies account for 10%. Worldwide data records about 17,500 butterfly species, with around 2,000-2,500 found in Indonesia (Kurniawan et al., 2020). As for moths, an estimated 270,000 species have been reported worldwide, with around 12,000 possibly present in the state (Sutrisno et al., 2015). Lepidoptera holds significant value and can be categorized into economic, ecological, aesthetic, and educational values. Based on literature and interviews with village officials, the potential of Ndodang forest has not been fully used for educational purposes. The diversity can be used to introduce locally based learning resources to enhance the knowledge and skills of students (Solihah et al., 2022).

This study aims to develop a SMART E-Encyclopedia of Lepidoptera diversity that is practical and user-friendly as a biology learning resource for Class X Students. The term SMART has the meaning and abbreviation for each letter. The letter S stands for "*Spesifik*" or specific, meaning unique to the material covered. Meanwhile, M stands for "*Mudah*" or easy, signifying that the learning resource is expected to facilitate the learning process for topics related to the Animal Kingdom or Invertebrates (Argarini et al., 2019). The letter A represents "*Audiovisual*," the video-based E-Encyclopedia engages students and facilitates independent understanding. The letter R stands for "*Realistic*" or realistic; the illustrations are related to real-life scenarios (Argarini et al., 2019). Furthermore, T symbolizes "*Teknologi*" or technology, indicating that the resource can be accessed anytime, anywhere, to familiarize students with 21st-century learning.

Research Method

This research was a Research and Development (R&D) research using the Borg and Gall development model (Sugiyono, 2016). This research was only carried out for eight

stages with the following steps: (a) potential problem, (b) data collection, (c) designing the template on Canva, (d) preparing the draft, (e) uploading the product on the flipbook, (f) validation, (g) revision according to the suggestion of the validator, and (h) uploading the revised product to the flipbook platform. The research instrument used was an e-encyclopedia feasibility validation instrument. The product validation stage involved a material expert, a media expert, and a Class X biology teacher. The validation results were analyzed for feasibility using the following formula:

$$PK = \frac{\sum x}{\sum xi} \times 100\%$$

After obtaining validation from all three validators, the results were combined as follows:

$$PK = \frac{V1 + V2 + V3}{3} = \dots\%$$

Description:

PK : Feasibility Percentage

$\sum X$: Total Validity Score

$\sum Xi$: Total Highest Score

V1 : Total Score from Validator 1

V2 : Total Score from Validator 2

V3 : Total Score from Validator 3, (Utami, S., 2021; Solihah, E. E., 2022).

The validation data was analyzed to conclude the feasibility of SMART E-Encyclopedia with the following criteria:


Table 1. Feasibility Criteria for SMART E-Encyclopedia (Khodijah et al., 2022)

Validation Score	Validity Category
81-100%	Very Feasible
61-80%	Feasible
41-60%	Quite Feasible
21-40%	Less Feasible
0-20%	Very Not Feasible

Results and Discussion

SMART E-Encyclopedia was developed based on the results regarding Lepidoptera diversity in Ndodang forest. This innovation was systematically and attractively organized to facilitate students in understanding diversity. The sections include the cover, author team, introduction, user instructions, table of contents, study location, introduction to Lepidoptera, various Lepidoptera species found, references, and author biography. The several designs from SMART E-Encyclopedia are as follows:

Table 1. Sections of SMART E-Encyclopedia

<p>S “SPESIFIK” or SPECIFIC</p> <ul style="list-style-type: none"> E-Encyclopedia was compiled with specific and specialized topics based on the results, specifically about Lepidoptera. 	
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M “MUDAH” or EASY

- In the table of contents, automatic links were created to navigate to each page that the reader wants to access by clicking on the desired subsection.
- The goal is to facilitate the search for the desired subsection.
- On each page, there was an arrow icon button located at the bottom left corner to return to the main table of contents.



A “AUDIOVISUAL”

- E-Encyclopedia included supplementary videos, consisting of original observations of Lepidoptera in Ndodang forest and video materials sourced from YouTube.
- However, YouTube video materials were downloaded and uploaded to Google Drive to avoid advertisements that could disrupt learning process.



R “REALISTIK” or REALISTIC

- Illustrations and images presented accurately depict the life of Lepidoptera in Ndodang forest.



T “TEKNOLOGI” or TECHNOLOGY

- E-Encyclopedia designed using Canva, was uploaded to Heyzine Flipbook, which is a user-friendly website directly integrated with Canva. Some advantages include a variety of presentation options, no maximum file size limit for uploads, and the ability to upload up to 5 files without payment and time constraints.





In the arrangement of the SMART E-Encyclopedia, the content was divided into introduction, content, and conclusion. The introduction included the cover page, author team, introduction, user instructions, and table of contents. The table of contents was automatically linked to each page, making it easier for students to navigate to desired sections. An automatic link was provided on the main page to facilitate returning to the table of contents. The content section comprised the location, a general introduction to Lepidoptera, and the species found. Meanwhile, the conclusion included the reference list and the author's biography.

E-Encyclopedia was also equipped with images, video links from YouTube, and videos of Lepidoptera taken during the visit to the location. Furthermore, the conveyed concept was easily understood using visual concepts through photos/images (Nanik & Faizah, 2019). According to research by Iman Taka (2018) and Putry et al. (2020), learning resources that utilize video media are more effective in improving student learning outcomes at the competency level in understanding the material and connecting it to everyday life. There were videos on the SMART E-encyclopedia to present more varied and not monotonous material so that students stay energized and are enthusiastic about paying attention to the material (Putry et al., 2020). Using digital media as a learning resource can train students' skills in using computers and internet facilities (Anshori, 2020). Digital learning resources offer diverse content presentations, including text, video, images, and audio, which can capture students' attention (Sulistri et al., 2020). The table of contents section is automatically linked to every page the reader wants to go to, and every page on the SMART E-encyclopedia also has an automatic link to return to the table of contents, which makes the SMART E-encyclopedia easier and more practical to use. Several studies on the preparation of learning resources have yet to maximize this. Selecting a link to the desired page is considered more accessible and more efficient for use on various devices when compared to using barcodes, which are pretty tricky if used only on one device in the form of a gadget (Nanik & Faizah, 2019).

The created SMART E-Encyclopedia was then subjected to validation to obtain feedback, comments, and suggestions and assess the product's feasibility percentage concerning content and media presentation. Validation was also employed to determine the quality of the developed learning resource (Suryani et al., 2018) and to determine the validity of the quality of the learning resources that have been developed (Yusup, 2018). The validation by material experts aims to assess the feasibility of SMART E-Encyclopedia material based on several components, including material relevance, accuracy, and supporting materials for learning. Similarly, media experts' validation assesses the media's feasibility based on the same components. Validation conducted by the Class X biology teacher covers material and media aspects. The results from all three validators were 53, 97, and 140 from material expert, media expert, and Class X teacher. Subsequently, the scores are converted into percentages to determine the feasibility of SMART E-Encyclopedia as a learning resource. The total score from each validator is calculated as a percentage as follows:

$$\text{Presentation of material expert validator} = \frac{53}{75} \times 100\% = 70\%$$

$$\text{Media expert validator percentage} = \frac{97}{100} \times 100\% = 97\%$$

$$\text{Percentage of Class X biology teacher validator} = \frac{140}{175} \times 100\% = 80\%$$

The validation data for the feasibility of the material in SMART E-Encyclopedia for Lepidoptera in Ndodang forest area yields a percentage of 70%, with the criteria that the

material is feasible for use. The score is based on the suggestions and comments from material experts, indicating that using the flipbook application in the product is good and attractive and incorporates elements of TPACK (Technological Pedagogical Content Knowledge). Therefore, SMART E-Encyclopedia aligns with 21st-century learning using technological aspects in education, specifically learning resources. It aligns with Fuad et al. (2020), who stated that internet technology can provide convenience and freedom in exploring knowledge. According to Khodijah et al., (2022), the material percentage of the butterfly booklet product, ranging from 60-80%, falls into the feasible use category.

The validation data yields a percentage of 93%, with the criteria that the product was highly feasible for use. The percentage stands as a testament to the robustness of Smart E-Encyclopedia, and this achievement is owed to the outstanding components of cover design and content display. The clarity in the presentation of species images is evident, alongside the curation of harmonious color variations and decorations, all contributing to a comprehensive and cohesive presentation. Additionally, there is access to audiovisual material to prevent readers from becoming easily bored. Clear image and text presentation, varied and attractive color design, and layout enhance the product's visual appeal while preventing monotony for readers (Anggraini et al., 2022). According to Wisada et al. (2019), adding videos to learning resources can make it easier for students to understand concepts realistically with audiovisual assistance.

The validation data for the feasibility of both material and media by Class X biology teacher yields a percentage of 80%, with the criteria that the product is feasible for use. The educational resource is captivating and practical for incorporation within the classroom environment, and the results are combined to obtain an average validation as follows:

$$PK(\text{Feasibility Percentage}) = \frac{70\% + 93\% + 80\%}{3} = 81\%(\text{Very Feasible})$$

Based on the results of the overall score by validator experts regarding the feasibility of the SMART E-Encyclopedia of Lepidoptera diversity in the Ndodang forest, it had a feasibility percentage of 81%, which showed that the SMART E-encyclopedia that had been prepared was in the very suitable category for use. It follows the product suitability category by Berliana et al. (2022), by Berliana et al. (2022), stating that the validity level of 81%-100% was at a quality level that is very suitable for use. Although the overall assessment by material experts, media experts, and high school class X biology teachers showed that the category was very suitable for use, SMART E-Encyclopedia would be revised according to suggestions from validators. The compiled encyclopedia could improve learning outcomes and facilitate students' understanding. In line with research (Rostikawati & Susanto, 2019), the learning process that uses encyclopedia learning resources can improve learning outcomes. The availability of learning resources in the teaching and learning process was vital. It plays an essential role in the development of students at school so that the knowledge and material they get from a teacher can be absorbed well (Sapriyah, 2019).

SMART E-Encyclopedia for Lepidoptera diversity in Ndodang forest has a product revised according to the suggestions from the validators to be used as a learning resource for Class X biology. Besides numerical scores, the assessment also includes suggestions and comments that can serve as a basis for improving the prepared Class X biology learning resource.

Table 3. Validators' Suggestion

Validator	Suggestions proposed
Material Expert	1. Writing species morphology based on the original morphology observed during the observation.

Media Expert	1. Correction of species names according to scientific nomenclature writing. 2. Video links should be made shorter so they are neater
Class X Biology Teacher	1. Addition of respiratory system material. 2. Addition of excretory system material. 3. In the metamorphosis section, a video is added that includes its endocrinological aspects.

Suggestions for revisions and improvements to the SMART E-Encyclopedia by the validators can be seen in the figures below.



Figure 1. Video link before revision



Figure 1. Video link after revision

The video link presented before the revision is still long and linked to YouTube, hence, learning time is not saved. After revision, links are made shorter, and the videos are put into one folder on Google Drive.



Figure 2. Addition of Physiology material based on the Biology teacher's suggestion

The biology teacher suggested adding Lepidoptera Physiology material, hence, after the revision was made; there was concise and easy-to-understand physiological material to facilitate students knowledge. Following the research results of Khodijah et al., (2022), adding explanations about the material's content can make the encyclopedia more exciting and accessible for students to understand. Additional material content includes the classification of each butterfly species and a description of butterfly morphology starting from the color of the wings, head, antennae, thorax, and abdomen.



Figure 3. Morphological content before revision



Figure 3. Morphological content after revision

Lepidoptera morphology before the revision is based on other results. The morphology of each part is detailed separately to provide a clear overview of the species.

The advantages of this e-encyclopedia are: a. From the content side., b. In terms of implementation.

- a) From the content side: (1) Contains about Lepidoptera (Butterflies and Moths) found in the Ndodang Forest, Ngawi district. (2). Explanation of broader material, which includes classification, habitat, morphology, living habits, global distribution of species, and videos of the life activities of each species. When found in the Ndodang forest, additional material videos and this video are without advertising interference. (2). The illustration is an image taken directly from the research location (Ndodang forest).
- b) In terms of implementation; this E-Encyclopedia is equipped with many application features to make it easier for users, including: (1). The table of contents is automatic. If you click it, you can go directly to the chapter or sub-chapter you want to read. (2). There is an arrow icon button on each page to return to the table of contents or the next page. (3). Embed a video that can be played directly and a G-drive link to the video. (4). Designed with Kanva and uploaded with Heyzine Flipbook, it has a large selection of features, unlimited file size, no payment, and no time limit (unlimited active period).

The development of the E-Encyclopedia from previous research has a different advantageous feature than the E-encyclopedia we developed above. Cahyani (2018) developed an insect encyclopedia in which the contents section contains pictures of species, descriptions, and additional information about the species. Then Azizah (2021) developed the design of the E-Encyclopedia (Taropedia or Talas Encyclopedia) with the Canva application and then coded it on the Android Studio application so that the Taro e-Encyclopedia can be accessed via mobile phone. This Taropedia content contains species images, classifications, and descriptions of the species' unique characteristics. Karimah (2021) also developed a digital encyclopedia based on process skills and character, which contains explanatory descriptions of biodiversity material accompanied by pictures. Work steps refer to process skills and the character of cooperation. Alfina (2021) developed a digital encyclopedia as a Flip using PowerPoint software, which was then saved in PDF format and imported into the professional Flip PDF application so that this encyclopedia could appear like a printed book. This e-Encyclopedia has a more attractive appearance than the previous three encyclopedias but is not equipped with automatic button icons in the table of contents, and there are no videos of butterfly species found in their habitat. Based on the comparison above, the E-encyclopedia of Ndodang debt butterflies that we have compiled has a small value that is more attractive and makes it easier for users.

Conclusion

SMART E-Encyclopedia was prepared following the study on Lepidoptera diversity in Ndodang forest area with the stages as follows: (a) designing the template on Canva, (b) preparing the draft, (c) uploading the product on the flipbook, (d) validation, (e) revision according to the suggestion of the validator, and (f) uploading the revised product to the flipbook platform. SMART E-Encyclopedia was subjected to validation by material expert, media expert, and Class X Biology teacher to obtain a score of 70%, 93%, and 80%, respectively. Based on the scores, the product had an average percentage of 81% and was feasible for use as a biology learning resource for Class X students. The advantages of this e-encyclopedia were: (1) Explanation of broader material; (2) This E-Encyclopedia is equipped with video and many application features to make it easier for users.

Recommendation

Recommended for further researchers: Further improvement should be carried out for SMART E-Encyclopedia, allowing us to use it without internet access, due to students facing signal challenges and residing in remote or mountainous areas.

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