BioEdu
Berkala Ilmiah Pendidikan Biologi
Vol. 14 No. 3 Tahun 2025 Hal: 541-552
https://ejournal.unesa.ac.id/index.php/bioedu

THE DEVELOPMENT OF INTERACTIVE E-BOOK "THE DIVERSITY OF TOGA PLANTS" TO TRAIN DIGITAL LITERACY SKILLS FOR 10th HIGH SCHOOL STUDENT

Pengembangan E-book Interaktif "Mengenal Keanekaragaman Tanaman Toga" untuk Melatihkan Keterampilan Literasi Digital Peserta Didik Kelas X SMA

Maurent Maulidiana Masitha
Biology Education, Faculty of Mathematic and Natural Science, State University of Surabaya
E-mail: maurent.20059@mhs.unesa.ac.id

Wisanti
Biology Education, Faculty of Mathematic and Natural Science, State University of Surabaya
E-mail: wisanti@unesa.ac.id

Abstract

Digital literacy, from a cognitive perspective, refers to the access, skills, and functional practices necessary to utilize technology effectively for personal, academic, and professional purposes. It plays a vital role for senior high school students by equipping them with the ability to use technology wisely, search for valid information, and develop critical thinking skills that support learning and daily activities. To address this need, this research aimed to develop an interactive e-book on the topic of TOGA (family medicinal plants) diversity to train students' digital literacy skills. The e-book was developed using the 4D model, which includes the Define, Design, Develop, and Disseminate stages. Research parameters included validity, practicality, and effectiveness. Validity was determined through expert judgment, practicality was assessed via readability tests and responses from teachers and students, and effectiveness was measured through concept mastery tests and the implementation of digital literacy indicators. Data were analyze quantitatively using descriptive statistics. The results showed that the e-book achieved a high validity score of 3.8, indicating highly valid in content, presentation, and language. Practicality was demonstrated through a readability score at level 10, with positive responses from teachers (100%) and students (98.5%). Effectiveness was evidenced by a concept mastery score of 88.3% and a digital literacy indicator score of 3.86, both classified as very good. Therefore, the e-book is considered a valid, practical, and effective medium for enhancing student digital literacy.

Keywords: digital literacy, e-book interactive, biodiversity plan, validity, practicality, effectiveness

Abstrak

Literasi digital dalam perspektif kognitif mencakup keterampilan dan praktik yang diperlukan untuk memanfaatkan teknologi secara pribadi, akademik, maupun profesional. Bagi siswa SMA, literasi digital berperan penting dalam membentuk kemampuan berpikir kritis, pencarian informasi yang valid, serta penggunaan teknologi secara bijak. Untuk mendukung penguasaan keterampilan tersebut, dilakukan penelitian pengembangan e-book interaktif berbasis materi keanekaragaman tanaman obat keluarga (TOGA) dengan tujuan melatihkan literasi digital. E-book dikembangkan menggunakan model 4D (Define, Design, Development, Disseminate) dan dievaluasi berdasarkan validitas, kepraktisan, dan keefektifan. Validitas diperoleh dari penilaian ahli, kepraktisan dari keterbacaan serta respons guru dan siswa, dan efektivitas dari hasil tes serta keterlaksanaan indikator literasi digital. Analisis data dilakukan secara deskriptif kuantitatif. Hasil menunjukkan e-book sangat layak (skor validitas 3,8), sangat praktis (keterbacaan level 10, respons guru 100% dan siswa 98,5%), serta sangat efektif (ketuntasan tes 88,3% dan skor indikator literasi digital 3,86). Dengan demikian, e-book ini dinyatakan valid, praktis, dan efektif untuk melatihkan keterampilan literasi digital siswa.

Kata Kunci: *Literasi Digital, E-book Interaktif, Keanekaragaman TOGA, Model 4D, Validitas, Kepraktisan, Efektivitas*

INTRODUCTION

The digitalization of the 21st century has brought significant transformation to education, demanding students to master basic literacy, competence, and character development. According to Nugraha and Octavianah (2020), six essential basic literacies include reading and writing, numeracy, science, digital literacy, financial literacy, cultural and civic literacy. The integration of technology into learning media—such as e-books, e-learning, and e-libraries—has become a crucial aspect of the educational process (Wijaya et al., 2016; Maksum et al., 2023). However, such integration must be supported by learning strategies that train critical thinking, communication, and collaboration (Sonia & Yuliani, 2022). In this context, digital literacy becomes a key skill in addressing the challenges of the digital age (Mardhiyah et al., 2021).

Digital literacy refers to the ability to communicate information through cognitive and technical use of communication and information technologies (Suherdi et al., 2021). This literacy is particularly important for high school students, as it equips them to use technology wisely, search for valid information, and develop critical skills that support both learning and daily life (Pangrazio et al., 2020). According to Gilster (1997), the four essential skills of digital literacy include internet searching, hypertextual navigation, content evaluation, and knowledge assembly. In line with this, A'yun and Wisanti (2024) assert that the integration of digital literacy in schools is a relevant response to technological advancement. However, improper use of technology in education remains common.

A survey by APJII (2022–2023) recorded 215.63 million internet users in Indonesia (78.19% of the population), yet the level of digital literacy remains low. Shiyamsyah and Yuliani (2022) argue that the lack of variety in learning media contributes to the low digital literacy among high school students. Their argument is supported by Kominfo (2023), which reports that Indonesian students' digital literacy level is only 62%, the lowest in ASEAN. Hence, there is a pressing need for effective and engaging learning media to guide students in addressing these challenges. Responding to this, the *Merdeka Curriculum* was introduced as an educational reform aimed at improving the quality of learning by emphasizing contextual education, adaptability, and the integration of technology into the teaching-learning process (Saa, 2024). According to Wardana et al. (2022), technology-based learning media can enhance student interest, stimulate curiosity, and train digital literacy skills.

Interactive learning media are digital technology-based tools that enable students to engage directly with learning materials, instructors, and peers, with the goal of increasing learning effectiveness and engagement (Amatullah & Sutrisno, 2022). Interactive learning emerges through interactions among teachers, students, environments, resources, and media (Faridah & Rahayu, 2022). This media integrates various multimedia elements such as text, images, audio, video, and animation to present material in an appealing and responsive manner. Key characteristics of interactive learning media include interactivity, self-instructional features, user-friendly interfaces, adaptability, and immediate feedback (Limbong et al., 2022; Manurung, 2020). The use of such media has been proven to boost motivation, learning flexibility, and student collaboration (Kusumawati et al., 2021; Fitriya et al., 2024), making it a vital component in promoting effective and inclusive education.

Research by Ambarwati and Putri (2019) revealed that biology textbooks that are used in high school exhibit low levels of digital literacy, rendering students more passive during learning. Devgeya et al. (2022) found that interactive digital learning media can improve student learning outcomes by 20%. Meanwhile, interviews with teachers at Atma Widya Senior High School in Surabaya revealed that physical textbooks and worksheets remain the primary learning resources. A prevalent issue in current textbooks is the inclusion of generic, globally common phenomena that are often irrelevant to students' daily lives (Kusumawardhani, 2021). Thus, there is a need for learning resources that can train digital literacy and elevate learning outcomes.

An e-book is a digital version of a printed book that incorporates text, images, audio, and other multimedia elements to create a more engaging and dynamic learning experience (Utomo, 2018; Prasetyono & Hariyono, 2020). Using applications such as Flipbook Maker, e-books can be enhanced with animations, videos, links, and audio, making them effective audiovisual learning resources (Amanullah, 2020; Rosita, 2017). As a 21st-century learning tool, e-books offer flexible access, content updates, quick search features, and interactive engagement through hyperlinks and multimedia (Nurhayati, 2017).

According to Kinanti and Raharjo (2021), e-books present a more visual and interactive learning experience that simplifies concept comprehension, making them a superior learning medium. A high-quality e-book should meet standards of content relevance, presentation, and

language clarity. The content should align with students' developmental stages (Vackova et al., 2023), the presentation should be interactive and accessible (Ozbay & Ugurelli, 2023), and the language should be clear and consistent (Shaked et al., 2020). With these advantages, e-books serve as modern learning media that are effective, inclusive, and adaptive to students' needs.

The use of e-books in education has proven effective in improving basic literacy skills such as phonological awareness, vocabulary development, and reading comprehension, particularly among young learners (López-Escribano et al., 2021; Zucker et al., 2009). Well-designed interactive e-books can enrich learning experiences while supporting the development of digital literacy, including critical thinking, content evaluation, and online navigation skills (Gilster, 1997; Zhang et al., 2023). Student and preservice teacher engagement in the use and development of e-books also trains mastery of digital information management and communication skills essential in the digital era (Smith & Sheridan-Ross, 2012; Tarigan et al., 2024).

Besides offering ease of access, affordability, and flexibility in digital learning, e-books also effectively support distance learning (Kaynar et al., 2020). However, challenges such as device limitations and the need for guidance from educators and parents must still be addressed. With ongoing supervision, e-books hold the potential to become innovative solutions for improving the quality of education in the digital era.

Biodiversity is one of the key concepts in biology learning within the Grade 10 Phase E *Merdeka Curriculum*. This topic emphasizes the importance of understanding the variation of life at genetic, species, and ecosystem levels as the foundation for nature conservation and human sustainability (Arianovita, 2022; Al Muhdhar et al., 2018). One real-life example of biodiversity closely related to everyday life is the presence of family medicinal plants (*Tanaman Obat Keluarga* or TOGA). TOGA refers to cultivated plants with medicinal properties (Najmah et al., 2020). These plants serve not only as traditional medicine sources but also play important roles in health, economic, social, and environmental conservation (Savitri, 2016; Najmah et al., 2020).

Implementing the *Merdeka Curriculum*, the development of 21st-century skills is a primary objective, including critical thinking, problem-solving, collaboration, and the use of digital technology (Rosadi & Megayanti, 2024). Consequently, integrating digital literacy into biology learning, especially regarding biodiversity, is highly relevant. Windaningrum (2023) emphasizes that digital literacy not only enhances students' technological skills but also strengthens character building and critical thinking.

Previous research by Setyoko (2023) shows that Android-based media focusing on local biodiversity can effectively improve students' digital literacy. One such innovation is a digital learning e-book focusing on TOGA plant diversity. This media enriches learning materials while addressing the scarcity of accessible resources on medicinal plants commonly found in everyday life. The use of TOGA biodiversity e-books to train Grade 10 students' digital literacy is relevant to the challenges of globalization and digitalization. This approach not only enhances comprehension but also demonstrates appropriate validity and readability for Grade 10 learners (Diana & Wisanti, 2020). The relevance of e-book use lies in its technological application, development of digital literacy, and the potential of natural resources (Riana, 2022).

The use of e-books featuring original photographs and structured based on the four indicators of digital literacy facilitates students in exploring new information and identifying TOGA species during the learning process. Digital literacy skills empower students to access accurate and up-to-date information resources wisely and to validate the information they find (Maisaroh & Supardi, 2023).

Nevertheless, challenges remain in optimizing biodiversity learning based on digital literacy. The lack of specific learning resources on TOGA plants and the limited integration of digital technology into these materials are issues that must be addressed. This study aims to develop and evaluate digital e-book learning media focusing on TOGA biodiversity, aligned with the *Merdeka Curriculum* learning objectives. Moreover, the study seeks to train students' digital literacy skills and enhance their understanding of the importance of conserving local biodiversity.

Based on the aforementioned context, this development research aims to produce an e-book entitled *"Exploring the Diversity of TOGA Plants,"* designed to train Grade 10 high school students in digital literacy, proven to be valid, practical, and effective both theoretically and empirically.

METHOD

This study is a development research employing the 4-D model (Define, Design, Develop, and Disseminate), selected for its concise procedure and structured stages (Putri & Wisanti, 2023). The research was conducted from

December 2024 to January 2025 in the Undergraduate Biology Education Program at Universitas Negeri Surabaya, with a limited trial carried out at Atma Widya Senior High School in Surabaya. The research subjects consisted of 20 Grade 10 students with diverse backgrounds in terms of gender and academic achievement during the even semester of the 2024/2025 academic year. The stages of this study—Define, Design, Develop, and Disseminate—are illustrated in the flowchart shown in Figure 1.

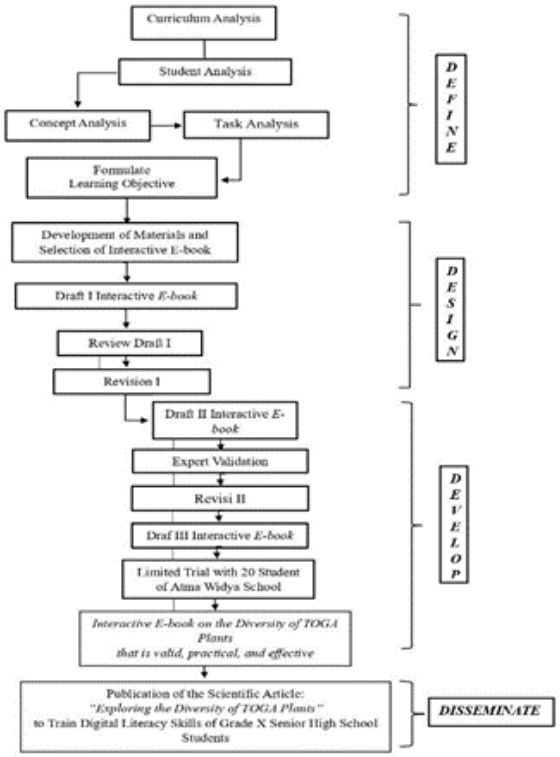

Figure 1. Flowchart of Model 4-D

The first stage of the development process is Define, which includes curriculum analysis, analysis of student characteristics, concept analysis, task analysis, and learning objective analysis. This stage aims to identify instructional needs, map the characteristics of Grade 10 students, and formulate the focus of interactive e-book development aligned with the learning outcomes of the *Merdeka Curriculum*. The second stage is Design, which involves prototyping the interactive e-book. In this phase, media selection, presentation format, and initial design development are carried out, incorporating various components such as text, images, videos, hyperlinks, and interactive features. These elements are designed to train digital literacy through indicators such as internet searching, hypertext navigation, content evaluation, and knowledge assembly.

The third stage, Develop, focuses on product development. The drafted e-book is reviewed and validated by subject matter experts and educational practitioners. Following revisions based on validation feedback, the product undergoes limited testing with 20 Grade 10 high school students to evaluate readability, user response, and its effectiveness in improving conceptual understanding and digital literacy skills. The final stage is Disseminate, which involves publishing the development results in the form of a scholarly article to broaden its impact among educators and students.

This research instruments include e-book validation sheets, teacher and student response questionnaires, post-tests, and observation sheets. Data collection techniques involve expert validation, readability tests, questionnaires, testing, and observation. The validity of the e-book is assessed by content and educational experts based on material, presentation, and language components, using a 4-point Likert scale. The average validity score is interpreted as follows: 1.00–1.75 = less valid; 1.76–2.50 = quite valid; 2.51–3.25 = valid; and 3.26–4.00 = highly valid (Akdon & Riduwan, 2020). Based on these criteria, the e-book is deemed valid if it receives a score of ≥ 2.51.

The practicality of the e-book is evaluated through readability analysis and student responses. Readability is analyzed using three text samples from the e-book with the Fry Graph method. Student and teacher responses are collected using a questionnaire that assesses presentation, content, and language aspects, applying a Guttman scale. These results, along with the readability findings, contribute to the assessment of the e-book's overall practicality. The percentage of teacher and student responses is interpreted using the following criteria: 0%–24% = less positive; 25%–49% = fairly positive; 50%–74% = positive; and 75%–100% = very positive. The e-book is considered practical if it obtains a response score of ≥ 50% (Akdon & Riduwan, 2020).

The effectiveness of the interactive e-book is measured through the observation of digital literacy skill activities. Observational data are organized into a table consisting of specific indicators rated on a 4-point Likert scale. Observed achievement is interpreted according to the following criteria: 1.00–1.75 = poor; 1.76–2.50 = fair; 2.51–3.25 = good; and 3.26–4.00 = very good (Pimentel, 2019). The e-book is considered effective if it achieves a score of ≥ 2.51.

Overall, the e-book is deemed feasible if it meets the minimum "valid" threshold, falls within the Grade 10–12

readability range, receives "positive" to "very positive" responses from teachers and students, and demonstrates "good" achievement in digital literacy skill indicators.

RESULT AND DISCUSSION

Profile of Interactive E-book

The interactive e-book "Getting to Know the Diversity of Toga Plants" consists of three main parts: introduction, content, and conclusion. The introduction includes the cover, instructions for use, e-book features, Learning Outcomes (CP), concept map, and Learning Objectives (TP). The main content includes interactive materials and activities with real-life examples divided into three topics: basic concepts of biodiversity, profiles and diversity of toga plants in Indonesia, and their utilization and conservation. The conclusion includes a bibliography, glossary, and author profile. The e-book design aligns with the statement by Al Faizah and Wisanti (2022), who noted that appropriate visualization of interactive instructional materials supports contextual understanding while developing students' digital literacy skills, such as searching, evaluating, and critically utilizing information (Al-Faizah & Wisanti, 2022).

The digital literacy skills trained in students include internet searching, hypertextual navigation, content evaluation, and knowledge assembly. These digital literacy skills are developed using the e-book's features: "B-Search," "B-Link," "B-Smart," "B-Think," "B-Talk," and "Quiz." The interactive e-book, designed in a flip format using professional flip PDF, is also equipped with video materials, high-quality original images, and reflection journals that can be used and completed online. The appearance of the interactive e-book and its characteristics are shown in Figure 2.

Figure 2. The appearance of the interactive e-book

Validity of Interactive E-book

The interactive e-book was submitted to expert lecturers for review and validation to assess the validity of the developed product. Validity was assessed from three aspects, namely presentation, content, and language.

Based on the results of the second draft validation, several improvements were made to the third draft of the interactive e-book. The title of the e-book was adjusted to represent the substance of the material better. Additionally, all features in the e-book now include explanations of the digital literacy skills indicators to be trained, including indicator markers for each activity. Appropriate sources or citations now accompany the images used.

Inappropriate punctuation and punctuation that does not comply with the General Guidelines for Indonesian Spelling (PUEBI) have also been corrected. To enhance the learning experience, the images in the e-book have been linked to the narrative material to create a clearer flow. Images of TOGA plants are now presented in full to clarify visual identification. Finally, a list of images containing all image citations has been compiled and included at the end of the e-book. The validation results by two expert lecturers as validators can be seen in Table 1.

Practicality of interactive e-book based on readability test

Readability tests using Fry graphs were used to measure the practicality of the e-books developed. The readability test was conducted by selecting 3 reading samples, each containing 100 words. In this study, the 3 sections were taken from the e-book on Chapter I (Basic Concepts of Biodiversity), Chapter II (Profile of Toga Plant Diversity), and Chapter III (Utilization of Toga Plants and Conservation Efforts). The results of the readability test can be seen in Table 2.

The results of the e-book readability test show that the developed e-book is at level 10. The number 10 obtained indicates that the discourse is suitable for 10th grade high school students, showing that the readability of the three e-book samples is at level 10. According to Inggriyani et al. (2022), the results on the Fry graph are estimates, allowing for a deviation of one level above or below, namely level 9 (10-1) or level 11 (10+1). This means that this e-book can be used by students from grade 9 to grade 11. The results of the readability test can be seen in Table 2.

Table 1. Validation Result of Interactive E-book

No	Assesment Aspect	Score		Average
		V1	V2	
A. Presentation Feasibility				
1.	E-book visual quality	4	3	3,5
2.	E-book cover	4	3	3,5
3.	Page layout	4	4	4
4.	E-book title	4	4	4
5.	Images	4	4	4
6.	Use of hyperlinks/QR codes	4	4	4
7.	Video quality	4	4	4
8.	Font suitability	4	4	4
9.	Operation technique	4	4	4
10.	Completeness of presentation	4	4	4
11.	User instructions	4	4	4
12.	Interactivity quality	4	4	4
Average				**3,9**
Interpretation				**Very Valid**
B. Content Feasibility				
1.	Scope and content relevance	4	4	4
2.	Content currency	4	3	3,5
3.	Integration of digital literacy	4	4	4
4.	Features in the e-book	4	4	4
Average				**3,87**
Interpretation				**Very Valid**
C. Language Feasibility				
1.	Language structure	4	3	3,5
2.	Terminology usage	4	4	4
Average				**3,75**
Interpretation				**Very Valid**

Based on the readability results obtained, aligned with the research by Himala et al. (2016), which states that the readability of activity-based textbook texts must align with students' reading ability levels, as assessed by word and sentence presentation. Additionally, the message conveyed in the e-book and students' readability levels are influenced by word and sentence writing.

Practicality of Interactive E-book Based on Teacher and Student Response

The practicality of e-books can be seen from the responses of teachers and students to e-books based on aspects of physical presentation, content, and language. The responses of teachers and students were then analyzed using a qualitative descriptive method based on the Guttman scale.

Based on the results summarized in Table 3, an overall average score of 98.5% was obtained, interpreted as “very good.” Therefore, it can be concluded that the use of interactive e-books to develop digital literacy skills received a very positive response from students and teachers for use in learning.

Teachers' and students' responses to the e-book showed very positive results, with an average score of 100% from teachers and 96% from students. The main challenge was found in the ease of use aspect, where 20% of students experienced technical difficulties such as unstable internet connections and unsupported devices. Additionally, blurry image quality when accessed via certain devices and limitations in using hyperlinks on smartphones posed challenges in using the e-book. Proposed solutions include switching networks, using alternative devices, or accessing the e-book in desktop mode.

Table 2. Readibility Analysis Using Graph Fry

Sample	Section Title	Page	Sentence Count	Syllable Count	Average of Syllable/ 100 Word	Grade Level
1	Types of Biodiversity	2	7	265	265 x 0,6 = 159	10
2	Diversity of TOGA Plants in East Java	25	4	242	242 x 0,6 = 145,2	10
3	Preservation TOGA Plants	46	5,5	254	254 x 0,6 = 152,4	10
Average			**5,5**	**253,6**	**152,2**	**10**

Table 3. Teacher and Student Response Questionnaire Results

No.	Aspect	Result (%)	
		Teacher (n=2)	Student (n-20)
A. Physical Presentation			
1.	Attractive visual presentation	100	100
2.	Easy to operate	100	80
3.	Cover relevance to topic	100	100
4.	User guide is easy to understand	100	100
5.	Clear image quality	100	100
6.	Accessible QR codes	100	100
7.	High-quality embedded videos	100	80
8.	Accessible hyperlinks	100	80
9.	Availability of interactive features (B-Search, etc.)	100	100
10.	Collaborative feature (B-Talk) works effectively	100	100
11.	Accessible on all devices	100	100
12.	Instructions and guidance for completing activities in the e-book are easy to understand.	100	80
B. Content Quality			
1.	Content is easy to comprehend	100	100
2.	Content aligns with the conceptual framework	100	100
3.	Comprehensive inclusion of biodiversity, TOGA plants, and conservation efforts	100	100
4.	Content included local reality approach and current issues related to TOGA	100	100
5.	Content presented digital literacy skills are practiced through feature: a. B-Search : *internet searching* b. B-Link : *hypertext navigation* c. B-Smart : *content evaluation* d. B-Think : *knowledge assembly*	100	100
C. Language aspect			
6.	Sentences are easy to understand	100	100
7.	Terminologies are clear and comprehensible	100	100
8.	No ambiguous or misleading sentences	100	100
Overall Average Score		**100**	**96**
Interpretation		**Very Positive**	**Very positive**

Effectiveness of Interactive E-books

The effectiveness of interactive e-books in training the digital literacy skills of 10th-grade high school students can be analyzed based on the achievement of digital literacy skill indicators. Effectiveness can be seen through the results of observations of the implementation of digital literacy skill activities related to diversity.

Based on the observation and assessment of the implementation of digital literacy skill indicators conducted on 20 tenth-grade students, as shown in Table 4, the interactive e-book developed is effective for training digital literacy skills, with an average implementation score of 3.86 and a very good interpretation.

Based on Table 4, the data on the achievement of the four digital literacy skill indicators trained to students shows a range of achievement between 3.7 and 4.00, with an overall average of 3.86 (on a scale of 4.00). The highest implementation score was for the internet searching indicator, with a score of 4.00, while the indicator with the lowest implementation completion was the content evaluation indicator, with a score of 3.73.

Table 4. Assessment of Digital Literacy Skills Indicators Results

No	Digital Literacy Indicator	Achievement Aspect	Average/Aspect	Average Score/Indicators	Interpretation
1	Internet Searching	Able to identify appropriate keywords related to biodiversity concepts	4	4	Very Good
2		Able to apply effective search strategies for relevant information	4		
3		Able to classify information based on relevance and credibility	4		
1	Penyusunan Pengetahuan (Knowledge Assembly)	Able to collect digital information about TOGA plant diversity	3,3	3,82	Very Good
2		Able to reconstruct information into comprehensive understanding	4		
3		Habitually composes reports, infographics, or digital presentations	4		
4		Able to organize scientific data into understandable digital formats	4		
1	Pandu Arah Hypertext *(Hypertextual Navigation)*	Able to follow hyperlinks to broaden understanding of TOGA plant utilization	4	3,9	Very Good
2		Understands digital text structure and conceptual relations	4		
3		Navigates websites and cross-references effectively	3,7		

No	Digital Literacy Indicator	Achievement Aspect	Average/Aspect	Average Score/Indicators	Interpretation
1	Evaluasi Konten Informasi *(Content Evaluation)*	Able to assess credibility of TOGA information from the internet	4	3,73	Very Good
2		Able to compare sources for accuracy	3,25		
3		Understands how to apply source evaluation criteria	4		
4		Can recognize hoaxes or misleading information related to TOGA	3,7		
Overall Average			**3,86**		
Interpretation			**Very Good**		

Ifadah and Prastiwi (2022) stated that the positive response from students received a very good percentage because the teaching materials could improve digital literacy skills. The research results showing the achievement of students' digital literacy indicators in the very good category cannot be separated from the effectiveness of the activities contained in the interactive e-book, with an overall average of 3.86 (very good category).

These activities are systematically designed to train digital skills through an exploratory and contextual approach. For example, internet searching skills, which received the highest score (4.00), were trained through the activity "Identifying Types of Biodiversity," where students were asked to search for information about local plants using appropriate keywords and credible digital sources. This activity encourages students to develop the ability to formulate search strategies and critically evaluate the results, which aligns with the measured digital skill indicators (Ifadah & Prastiwi, 2022).

Furthermore, hypertextual navigation skills, which scored 3.90, were developed through the activity "Exploring the Digital World: Discover the Benefits of TOGA Plants." In this activity, students are guided to explore various websites using hyperlinks, navigation menus, and instructional videos. This process not only enhances non-linear digital navigation skills but also encourages cross-source information exploration to broaden understanding. Meanwhile, the knowledge assembly aspect is developed through organizing information from various sources into structured tables or diagrams, contributing to a score of 3.82 on that indicator.

However, in the content evaluation aspect, which received the lowest score (3.73), it was found that students still face challenges in evaluating the truthfulness of information from social media-based discourse or digital articles. Activities such as "Analyzing the Truth of Facts in Social Media Posts" were designed to train this ability, but the results showed that students need further training in distinguishing valid claims from hoaxes and understanding the complexity of issue-based environmental questions. It indicates that the content evaluation aspect still needs to be strengthened, particularly in terms of discourse interpretation and understanding of argumentative logic. According to Azizah and Wisanti (2024), the use of e-books trains students to adapt to digital technology, which is an important part of digital literacy.

Thus, the use of interactive e-books as a learning medium has proven to be not only valid and practical but also effective in simultaneously training digital literacy. This aligns with research by Shiyamsyah and Yuliani (2022), which also shows that e-books are considered highly effective by students because they can develop digital literacy skills in a learning context, supporting the conclusion that digital instructional materials can enhance the effectiveness of 21st-century competency-based learning.

This finding reinforces the relevance of George Siemens' (2004) connectivism theory, which states that students build knowledge through the exploration and connection of relevant information, both independently and collaboratively. Therefore, the development of

digital learning media such as e-books is not only an alternative but a strategic solution to strengthen students' competency achievement in the digital era.

CLOSING

Conclusion

Based on the research conducted, it can be concluded that the interactive e-book *"Exploring the Diversity of TOGA Plants"* is highly valid, with an average score of 3.8 derived from the validation of its presentation, content, and language aspects. In addition, the e-book is also deemed highly practical, as indicated by the readability test results which place it at grade level 10 (appropriate for Grade 10th senior high school students), and the very positive responses from both teachers and students, with respective scores of 100% and 98.5%. In terms of effectiveness, the e-book has been proven to be highly effective in training digital literacy skills, with an indicator achievement score of 3.86, categorized as very good.

Therefore, the developed interactive e-book not only meets the criteria of validity, practicality, and effectiveness but is also highly suitable as an innovative instructional material to support the enhancement of students' digital literacy in the era of technology-based learning.

Suggestion

Similar research can be conducted on other instructional materials to further enhance students' digital literacy skills. Moreover, the development of e-books aimed at training digital literacy should also be integrated with specific learning models, so that e-book-based learning activities can be implemented more effectively and optimally.

Acknowledgments

The author would like to express the deepest gratitude to the validator lecturers and examiners, Prof. Dr. Yuni Sri Rahayu, M.Si., and Dr. Raharjo, M.Si., Sunda Mulyaningsih, S.Pd., as biology teachers and validators, and Atma Widya Senior High School class X-1 students who have become participant subject in this study.

REFERENCES

Akdon, dan Riduwan.(2020). Rumus Dan Data dalam Analisis Statistika untuk Penelitian. Jakarta: Alfabeta

Al Faizah, A., & Wisanti, W. (2022). Development of Pterintifier (Pteridophyta Identifier) Based on as a Learning Source and to Train Digital Literacy for 10th Grade in Senior High School. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *11*(2), 312-320. https://doi.org/10.26740/bioedu.v11n2.p312-320

Al Muhdhar, MHI, *et al.* (2018). Keanekaragaman Tumbuhan Rempah dan Pangan Unggulan Lokal. Universitas Negeri Malang Press.

Amanullah, M. (2020). Pengembangan Media Pembelajaran *Flipbook* Digital Guna Menunjang Proses Pembelajaran di Era Revolusi Industri 4.0. *Jurnal Dimensi Pendidikan dan Pembelajaran*, 8(1), 37-44

A'yun, Q., & Wisanti, W. (2024). Kelayakan Website Pembelajaran Materi Keanekaragaman Hayati Berbasis Potensi Lokal Gresik untuk Melatihkan Keterampilan Literasi Digital. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, 13(3), 618-628.

Azizah, E. N., & Wisanti, W. (2024). Pengembangan *E-book* Tranpor Membran Berbasis Pendekatan SAINTIFIK untuk Melatih Keterampilan Berpikir Kritis. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, 13(2),266-276.

Diana, N. P., & Wisanti, W. (2021). The Development of *E-book* Knowing Bryophyta Diversity to Train Digital Literacy. *Berkala Ilmiah Pendidikan Biologi (BioEdu),* 10(1), 40-48.

Devgeya, A., Ambiyar, A., Panyahuti, P., Adi, N., dan Riyanda, A. (2022). The Effectiveness of Learning Media on The Outcome of Computer and Basic Network of Vocational Students. *Jurnal Pendidikan Teknologi Kejuruan.*

Faridah, U., Rahayu, Y. S., & Dewi, S. K. (2022). Pengembangan E-Modul Interaktif untuk Melatihkan Keterampilan Literasi Sains Siswa Materi Transpor Membran. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *11*(2), 394-404.

Gilster, P. (1997). Digital Literacy. New York: Wiley Computer Publications.

Gronlund, N.E. (2013). *Constructing Achievement Test Third Edition*. London: Practice Hall, Inch.

Ifadah, E., dan Prastiwi, M. S. (2022). Keefektifan Pembelajaran Daring pada Materi Biologi dalam Meningkatkan Literasi Digital Siswa. *Berkala Ilmiah Pendidikan Biologi (Bioedu)*.11(1), 228-239

Inggriyani, F., Dindin, M. Z. M., Gunawan, M., & Praja, A. L. (2022). Grafik *Fry* dalam Mengukur Keterbacaan Wacana Buku Tematik Kelas IV Sekolah Dasar. *Didaktik: Jurnal Ilmiah Pgsd Stkip Subang*, *8*(1), 98–115.

Kinanti, A. R., & Raharjo, R. (2021). The Validity and Readability of Ebook on Immune System to Upskill

Students Scientific Literacy. *Berkala Ilmiah Pendidikan Biologi (BioEdu),* 10(3), 647-654.

Kusumawati, L. D., dan Mustadi, A. (2021). Kelayakan Multimedia Pembelajaran Interaktif dalam Memotivasi Siswa belajar Matematika. *Kwangsan: Jurnal Teknologi Pendidikan*, 9(1), 31-51.

Limbong, M., Fahmi, F., dan Khairiah, R. (2022). Sumber Belajar Berbasis Media Pembelajaran Interaktif di Sekolah.. *Decode: Jurnal Pendidikan Teknologi Informasi*, *2*(1), 27-35.

López-Escribano, C., Valverde-Montesino, S., dan García-Ortega, V. (2021). The Impact Of *E-book* Reading On Young Children's Emergent Literacy Skills: *An Analytical Review. International Journal Of Environmental Research And Public Health*, 18.

Mardhiyah, R. H., et al. (2021). Pentingnya Keterampilan Belajar di Abad 21 sebagai Tuntutan dalam Pengembangan Sumber Daya Manusia. *Lectura: Jurnal Pendidikan*, 12(1), 29-40.

Muhammad, Ridwan dan Ambarwati, R.(2021).Pengembangan *E-book* Keanekaragaman Hayati sebagai Sumber Belajar untuk Melatihkan Literasi Digital Siswa Kelas X SMA. *Berkala Ilmiah Pendidikan Biologi(Bioedu)*. 10 (2), 326-334

Najmah. I, H. Ar Rahma, C A, *et al*. (2023). *Mengenal 33 Jenis Toga di Arboretum Tanaman Obat Keluarga*.Yogyakarta: Bintang Semesta Media. *I*(1). 11-38

Nurhayati, D.(2017). Pengembangan Buku Digital Interaktif Mata Kuliah Pengembangan *E-Learning* pada Mahasiswa Teknologi Pendidikan FIP UNY. E-Jurnal Skripsi Program Studi Teknologi Pendidikan. 6(5), 458-473.

Ozbay, I., & Ugurelli, Y. O. (2023). Changing Children's Literature in the Digital Age: Digital Books. *International Journal of Education and Literacy Studies,* 11(1), 68-85.

Pangrazio, L., Godhe, A. L., & Ledesma, A. G. L. (2020). What is Digital Literacy? A Comparative Review of Publications Across Three Language Contexts. *E-learning and Digital Media*, *17*(6), 442-459.

Prasetyono, R., dan Hariyono, R. (2020). Development Of Flipbook Using Web Learning To Improve Logical Thinking Ability In Logic Gate. *International Journal Of Advanced Computer Science And Applications*, 11(1), 342-348.

Putri, F. M., dan Wisanti, W. (2023). Pedoman Penulisan Artikel E-Journal Unesa Pengembangan LKPD Paku Berbasis Learning Cycle 5E untuk Melatihkan Keterampilan Berpikir Kritis Siswa Kelas X SMA. *Berkala Ilmiah Pendidikan Biologi (Bioedu)*, 12(2), 365-379.

Rachmadiarti, F. (2020). Validitas *E-book* Interaktif pada Materi Keanekaragaman Hayati untuk Melatihkan Keterampilan Berpikir Kritis Siswa Kelas X SMA. *Berkala Ilmiah Pendidikan Biologi (Bioedu)*, 9(2), 140-149.

Raharjo, N. P., dan Winarko, B. (2021). Analisis Tingkat Literasi Digital Generasi Milenial Kota Surabaya dalam Menanggulangi Penyebaran Hoaks. *Jurnal Komunika: Jurnal Komunikasi, Media dan Informatika*, 10(1), 33-43.

Rahmatsyah, S. W., & Dwiningsih, K. (2021). Development of Interactive E-Module on The Periodic System Materials as An Online Learning Media. J*urnal Penelitian Pendidikan IPA*, 7(2), 255.

Riana, F., Al Ikhsan, S. H., Makbul, F. R., dan Kusumah, F. S. F. (2022). Aplikasi Augmented Reality Pengenalan Tanaman Obat Keluarga (Toga) Berbasis Android. *Krea-Tif: Jurnal Teknik Informatika*, 10(2), 68-78.

Rosadi, N., dan Megayanti, W. (2024). Contribution of the Kurikulum Merdeka in Efforts to Increase Literacy Capabilities in Indonesia. *Nitisara*, 2(1), 7-11.

Rosita, C. D., Laelasari, L., & Noto, M. S. (2014). Analisis Kemampuan Pemahaman Matematis Mahasiswa pada Mata Kuliah Aljabar Linear 1. *Euclid*, 1(2).

Saa, S. (2024). Merdeka Curriculum: Adaptation of Indonesian Education Policy in The Digital Era and Global Challenges. *Revista de Gestao Social e Ambiental,* 18(3),1-24.

Sakdiah, H., dan Jamilah, M. (2022). Digital Literacy Students Facing to Independent Learning Independent Campus Curriculum. *Community Medicine and Education Journal*, 3(1), 217-222.

Setyoko, S., Wahyuni, A., dan Priyanda, R. (2023). Development of Android Application on Digital Literacy: The Use of Technology Media For High School. *Al-Ishlah:Jurnal Pendidikan.* https://Doi.Org/10.35445/Alishlah.V15i2.2582.

Shaked, K., Shamir, A., & Vakil, E. (2020). An Eye Tracking Study of Digital Text Reading: A Comparison Between Poor and Typical Readers. *Reading and Writing*, 1-20. https://doi.org/10.1007/s11145-020-10021-9.

Shiyamsyah, F. S. F, dan Yuliani, Y. (2022). Pengembangan *E-book* Interaktif pada Materi Respirasi Seluler untuk Melatihkan Kemampuan

Literasi Digital Peserta didik SMA Kelas XII. *Berkala Ilmiah Pendidikan Biologi (Bioedu),* 11(2), 492-501.

Sonia S, dan Yuliani. (2023). Keefektifan Penggunaan *E-book* Interaktif Enzim sebagai Bahan Ajar untuk Melatihkan Kemampuan Literasi Digital. Jurnal Inovasi Pembelajaran Biologi, 4(2), 113-124.

Sujimat, D. Agus. 2000. *Penulisan karya ilmiah.* Makalah disampaikan pada pelatihan penelitian bagi guru SLTP Negeri di Kabupaten Sidoarjo tanggal 19 Oktober 2000 (Tidak diterbitkan). MKKS SLTP Negeri Kabupaten Sidoarjo

Suherdi, Devri et al., (2021). *Peran Literasi Digital di Masa Pandemi.* Cattleya Darmaya Fortuna.

Thiagarajan, S., Semmel, D. S., dan Semmel, M. I. (1974). Instructional Development For Training Teachers of Exceptional Children: A Sourcebook. Indiana University, Bloomington: Center for Innovation in Teaching The Handicapped.

Usada Bali. (2021). Manfaat Jahe untuk Kesehatan. *Widya Kesehatan*, 1(2), 39-43.

Vacková, P., Cermakova, A., & Kucirkova, N. (2023). *Children's Digital Books: Development, Testing and Dissemination of Quality Criteria*. University of Stavanger Press. https://doi.org/10.31265/usps.268.

Wardana, M. A. W., Febriana, N., Karina, Y. K., Mulyono, S., dan Sasmito, E. (2022). Pengembangan Media Pembelajaran *Pull Out Photo Box* sebagai Upaya Peningkatan Pemerolehan dan Pembelajaran Bahasa Bagi Anak Berkebutuhan Khusus (ABK) pada Sekolah Inklusi Tingkat Dasar. *Improvement: Jurnal Ilmiah untuk Peningkatan Mutu Manajemen Pendidikan*, 9(1), 42-54.

Yuliana, F. H., Firmansyah, F., & Pratita, D. (2024). Media Pembelajaran Interaktif *Liveworksheets* dengan Pendekatan *Case Based Learning*: Preliminary Study. *Jurnal PIPSI (Jurnal Pendidikan IPS Indonesia)*, *9*(2), 116-125.

Zhang, Y. (2021). Applying Digital Technology to Linguistic Education: A Connectivism-Based Intelligent Learning System. *2021 3rd International Conference on Internet Technology and Educational Informization (ITEI)*, 111-115. https://doi.org/10.1109/ITEI55021.2021.00034