BioEdu
Berkala Ilmiah Pendidikan Biologi
Vol. 13 No. 2 Tahun 2024 Hal: 490-502
https://ejournal.unesa.ac.id/index.php/bioedu

THE DEVELOPMENT OF E-WORKSHEET "DIVERSITY OF FERNS" BASED ON A SCIENTIFIC APPROACH TO TRAIN STUDENTS' CRITICAL THINKING SKILLS

Pengembangan E-LKPD Keanekaragaman Tumbuhan Paku-Pakuan Berbasis Pendekatan Saintifik untuk Melatihkan Keterampilan Berpikir Kritis Peserta Didik

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Abstract

Critical thinking skills is a crucial competency for the 21st century and is essential for students. The scientific approach can be applied in the teaching and learning process to train students' critical thinking skills through electronic-based teaching materials. This research aims to create an e-worksheet on the diversity of ferns using a scientific approach to train critical thinking skills that are valid, practical, and effective. The research method is applying the 4D development model (Define, Design, Develop, and Disseminate). The e-worksheet product was tested on a limited basis with 20 students from class X-1 at MAN 2 Gresik. Research parameters in developing the E-worksheet include the validity based on expert assessments, the practicality based on its implementation, and the effectiveness based on the achievement of critical thinking skills and student responses. Research instruments include validation assessment instruments, implementation observation sheets, critical thinking assessments, and student response questionnaire. Data analysis was conducted descriptively and quantitatively. The analysis results indicate that the E-worksheet's validity is 3.97 (very valid), its practicality is 97.29% (very good), and its effectiveness in terms of the achievement of critical thinking skills, indicators of interpretation, analysis, evaluation, and explanation respectively worth 85%, 85%, 100%, and 100% (very good), as well as positive responses from students worth 98.82% (very good). Thus, this E-worksheet is declared valid, practical, and effective, so it is suitable to be applied to train students' critical thinking skills.
Keywords: critical thinking, scientific approach, E-worksheet, diversity, ferns

Abstrak

Keterampilan berpikir kritis merupakan salah satu keterampilan penting pada abad ke-21 dan sangat dibutuhkan peserta didik. Pendekatan saintifik dapat dimanfaatkan untuk proses belajar mengajar guna melatihkan keterampilan berpikir kritis peserta didik menggunakan bahan ajar berbasis elektronik. Tujuan penelitian yakni menghasilkan E-LKPD keanekaragaman tumbuhan paku-pakuan berbasis pendekatan saintifik untuk melatih keterampilan berpikir kritis yang valid, praktis, dan efektif. Metode penelitian yaitu menerapkan model pengembangan 4D (Define, Design, Develop, dan Disseminate). Produk E-LKPD yang dihasilkan diujicobakan kepada 20 orang peserta didik kelas X di MAN 2 Gresik. Parameter penelitian dalam pengembangan E-LKPD ini meliputi validitas berdasarkan penilaian ahli, kepraktisan berdasarkan keterlaksanaan E-LKPD, serta keefektifan berdasarkan ketercapaian keterampilan berpikir kritis dan respons peserta didik. Instrumen penelitian berupa instrumen penilaian validasi, lembar observasi keterlaksanaan, soal tes keterampilan berpikir kritis, dan angket respons peserta didik. Data dianalisis secara deskriptif kuantitatif. Hasil analisis menunjukkan bahwasanya E-LKPD mendapatkan validitas senilai 3,97 (sangat valid), kepraktisan senilai 97,29% (sangat baik), dan keefektifan ditinjau dari ketercapaian keterampilan berpikir kritis indikator interpretasi, analisis, evaluasi, dan eksplanasi secara berurutan senilai 85%, 85%, 100%, dan 100% (sangat baik), serta respons positif peserta didik senilai 98,82% (sangat baik). Dengan demikian, E-LKPD ini dinyatakan valid, praktis, dan efektif, sehingga layak diterapkan untuk melatihkan keterampilan berpikir kritis peserta didik.
Kata Kunci: *berpikir kritis, pendekatan saintifik, E-LKPD, keanekaragaman, tumbuhan paku*

INTRODUCTION

The 21st century has been called the century of knowledge characterized by rapid advances in information technology, especially in the field of education (Mardhiyah et al., 2021). It is not only knowledge that is relied upon, but the role of skills is also crucial in learning in this century. According to Redhana (2019), skills in the 21st century are often referred to as 4C skills, including collaboration, communication, creativity, and critical thinking. Therefore, the Indonesian government can evaluate the quality of education and teachers by creating interesting learning so that students can have 4C skills.

Indonesia has demonstrated its commitment to improving the quality and quality of education through the presence of the *Kurikulum Merdeka*, this step was taken to face increasingly fierce competition for human resources globally in the 21st century (Indarta et al., 2022). One of the aspects emphasized in the *Kurikulum Merdeka* is strengthening the *Profil Pelajar Pancasila*, which is part of efforts to prioritize character formation in Indonesia (Rachmawati et al., 2022). The *Profil Pelajar Pancasila* includes competencies and character consisting of six dimensions, including faith, devotion to God Almighty and noble character, global diversity, cooperation, independence, critical reasoning, and creativity (Kemendikbud, 2021). One important dimension is critical reasoning ability. To achieve critical reasoning abilities, critical thinking skills are needed.

Facione (2015) states, that critical thinking is a type of thinking that has the aim of proving, explaining the meaning of something, and solving problems. There are six indicators of critical thinking, including interpretation, analysis, explanation, evaluation, inference, and self-regulation. A person can respond and analyze all the problems they face through critical thinking skills. So critical thinking skills are considered very important and necessary for every graduate from various levels of education (Zubaidah, 2019).

The facts found in Indonesia are that students' critical thinking skills are still relatively low. This is supported by the results of Agnafia's research (2019), proving that there are 24 students whose self-regulation, evaluation, and analysis abilities are respectively 51%, 46%, and 31% categorized as low. The low critical thinking skills of students are suspected to be due to the lack of implementation of learning strategies that can improve critical thinking skills (Wahyudi et al., 2020).

Developing thinking skills requires innovative strategies in biology learning. Teachers can apply these strategies in an interesting and systematic learning process using a scientific approach that develops 21st century skills (Usman et al., 2022). The scientific approach is a learning method that facilitates students' active participation in developing concepts, laws, or principles using scientific methods (Lestari, 2020). In the *Kurikulum 2013*, the scientific approach consists of five steps, namely observing, asking, collecting data, associating, and communicating. In the *Kurikulum Merdeka*, this approach remains very relevant, especially in the context of project-based learning (Jannah & Naimi, 2023).

The innovation that can be carried out to train critical thinking skills is through the development of teaching materials based on a scientific approach. student worksheets are examples of teaching materials that can be developed. However, student worksheets has now begun to be converted into electronic form, namely E-worksheet, to support technological developments. E-worksheet are a type of teaching material that is structured in one learning unit in electronic format, which includes images, animations, and video navigation to increase user interactivity with the program (Puspitasari, 2019).

Based on this, developing E-worksheet requires a platform that can display E-worksheet attractively online. One solution is to use the Liveworksheets site. Liveworksheets is a platform that allows users to convert conventional student worksheets in various formats (document, PDF, JPG) into interactive online exercises that can perform automatic corrections (Haezer et al., 2023). Research conducted by Rahmawati et al., (2022) shows that the use of E-worksheet based on Liveworksheets on circulation system material significantly increases high school students' critical thinking abilities. The research results showed a very good category in the aspects of interpretation (99.40%), analysis (90.42%), evaluation (91.11%), inference (83.45%), explanation (97.36%), and self-regulation (85.08%).

The learning outcomes for the biology understanding element are that at the end of phase E, students can create solutions to problems based on local, national, or global issues related to understanding the diversity of living things and their roles, viruses and their roles, biological technological innovation, ecosystem components and interactions between components. as well as environmental changes. E-worksheet teaching materials that integrate the stages of a scientific approach are in line with the learning outcomes of process skills

elements so that they can be used as a means to meet these learning outcomes.

Ferns plant material is one of the topics in biology subjects that can be used to train students' critical thinking skills. Ferns are part of the Plantae material which is currently included in the Diversity and Classification of Living Things. Fern plant material in high school is still considered difficult because students cannot understand the differences between the ferns plant group and other plant groups. Based on research by Cahyani (2023), it is stated that one of the difficult things in 10th grade biology lessons in high school is the material on Ferns (Pteridophyta). Selecting the right learning media and collaborating with technology can be done to overcome this problem, for example by using E-worksheet.

Based on the explanation above, this research aims to determine the feasibility of the E-worksheet "Diversity of Ferns" based on a scientific approach to train students' critical thinking skills in terms of the results of validity, practicality, and effectiveness.

METHOD

This development research refers to the Four-D Models which includes the Define, Design, Develop, and Disseminate stages. The use of Four-D model development was chosen because this model is systematic and detailed so that it can facilitate the process of developing tools and instruments (Jatmiko & Fiantika, 2017). The research took place from February 2023 to May 2024. The subjects of this research were 20 students in class X-1 at MAN 2 Gresik.

The define stage consists of student analysis activities, curriculum analysis, concept analysis, and task analysis. The ferns diversity material presented at E-worksheet adapts the *Kurikulum Merdeka* to the Learning Outcomes for Phase E. Students aged 15-16 years can think critically and logically in studying the topic of ferns diversity which covers extensive material and difficult to understand. Analysis of the concepts that will be taught regarding Diversity of Ferns includes general characteristics, classification, benefits of ferns, and threat of fern problems. Based on the learning outcomes to be completed, task analysis includes activities that integrate the five activities, namely observing, asking, collecting data, associating, and communicating.

The design stage includes activities to prepare the contents of the E-worksheet "Diversity of Ferns", starting from the cover page, and introduction, to the features of the E-worksheet with activities based on a scientific approach and practicing critical thinking. Two topics are included in the E-worksheet, namely E-worksheet topic I with the topic of diversity and classification of ferns, while E-worksheet topic II with the topic of issues and problems with the diversity of ferns. The time allocation for each E-worksheet is 3x45 minutes.

The develop stage includes E-worksheet development activities carried out from February 2023 to May 2024. The develop stage is carried out to determine the feasibility level of E-worksheet. This activity includes reviewing draft I of the E-worksheet by the supervising lecturer and then revising it, resulting in draft II. Next, draft II will be reviewed by media expert lecturers and material experts, then revised to produce draft III, namely the final draft of the E-worksheet "Diversity of Ferns". The trial was carried out on a limited basis on 20 students from class X-1 at MAN 2 Gresik. Meanwhile, the disseminate stage is through the activity of publishing research results in the form of scientific articles.

The parameters of this research include the validity, practicality, and effectiveness of E-worksheet. The validity assessment was carried out by material experts and media experts from the Biology Education Study Program. The validity assessment instrument includes aspects of presentation, content, and language and is guided by a 4-point Likert scale, 1 – 4 (not good – very good). The average score from the validation results is calculated and then interpreted using the validity criteria: 1.00 – 1.75 (less valid), 1.76 – 2.50 (quite valid), 2.51 – 3.25 (valid), and 3.26 – 4.00 (very valid). E-worksheet is declared valid if the average validation score is ≥2.51 (Riduwan, 2016).

The practicality of E-worksheet was determined based on observations of the implementation of E-worksheet by four observers using an observation sheet containing 12 observed student activities. Each observer observes a group consisting of five students. The scores given on the observation sheet are guided by the Guttman scale, namely Yes (1) and No (0). The score for each aspect of the observation carried out is determined by percentage and interpreted using practical criteria: 0% – 40% (not good), 41% – 55% (less good), 56% – 70% (quite good), 71% – 85% (good), and 86% – 100% (very good). E-worksheet is declared practical if the percentage of implementation is ≥71% (Riduwan, 2016).

The effectiveness of E-worksheet is determined based on critical thinking skills test scores and students' positive responses to E-worksheet. The test consists of 7 questions, namely 2 interpretation indicator questions, 3

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analysis indicator questions, 1 evaluation indicator question, and 1 explanation indicator question. The results of the critical thinking ability test are in the form of scores and are categorized according to Fausan, et al., (2021): 0 – 50 (very low), 56 – 59 (low), 60 – 75 (quite), 76 – 85 (good), and 86 – 100 (very good). E-worksheet is declared effective if the percentage of students who obtain good to very good criteria for critical thinking ability indicators is ≥70% (Riduwan, 2013). Students' positive responses were obtained by providing a 20-item questionnaire. The scoring for each question item is guided by the Guttman scale, namely Yes (1) and No (0). The scores obtained are calculated in percentages and interpreted using the following criteria: 0% – 40% (not good), 41% – 55% (less good), 56% – 70% (quite good), 71% – 85% (good), and 86% – 100% (very good) (Riduwan, 2016).

RESULT AND DISCUSSION

Profile of E-worksheet

The product resulting from the research is the E-worksheet "Diversity of Ferns" based on a scientific approach to train students' critical thinking skills based on an assessment of validity, practicality, and effectiveness. The E-worksheet product consists of an introduction, a contents section, and a closing section. The developed E-worksheet profile is shown in Figure 1.

(a)

(b)

(c)

(d)

(e)

(f)

Figure 1. E-worksheet parts; (a) main cover page; (b) E-worksheet display; (c) E-worksheet cover page topic I; (d) E-worksheet learning activities topic I; (e) cover page of E-worksheet topic II; (f) E-worksheet learning activities topic II.

The E-worksheet was designed to follow advances in information technology which is an important focus in the 21st century (Wijaya et al., 2016). The way to access E-worksheet is by using a laptop or smartphone that has an internet connection so it can be opened online. The preparation of the E-worksheet is designed using the Canva application and then the results are saved in portable document format (PDF) in .pdf format and converted into an E-worksheet which can be accessed via Google on the Liveworksheets site (https://www.Liveworksheets.com/). On this site, E-worksheet answers can be typed directly and the display can be reduced or enlarged to suit the user's wishes and needs. The contents of the E-worksheet also provide a QR Code which allows it to be scanned to make it easier for students to complete learning activities. There are hyperlinks on E-worksheet to make it easier to open the desired site or page. E-worksheet is also equipped with pictures and videos to strengthen information and add new insights related to the Diversity of Ferns material being taught.

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The E-worksheet product consists of two discussion topics contained in E-worksheet topic I and E-worksheet topic II. E-worksheet topic I contains material "Diversity and Classification of Ferns", while E-worksheet topic II contains material "Problems and Issues of Ferns Diversity". The designed E-worksheet has been integrated with a scientific approach, each stage of which is useful for practicing critical thinking skills. The four critical thinking skills trained are interpretation, analysis, evaluation, and explanation. The E-worksheet features are presented in Table 1.

Table 1. Features of E-worksheet "Diversity of Ferns"

E-worksheet Features	Description
Ferns-Observing 	This feature directs students to read articles and observe the images/videos displayed then answer several questions that have been provided to practice interpretation skills.
Ferns-Asking 	This feature directs students to make three questions regarding the information they want to know to practice interpretation and analysis skills.
Ferns-Exploring 	This feature contains introductory material, images, QR Codes, and hyperlinks as a medium for students to collect the data and information needed to fill in the observation results table. This feature trains interpretation and analysis skills.
Ferns-Associating 	This feature invites students to analyze and relate the information they have obtained through answering questions to practice analysis, evaluation, and explanation skills.
Ferns-Communicating 	This feature directs students to explain and present the results of their work in various ways, either through Power Point or posters. This feature trains explanation skills.
Ferns-Glossary 	This feature is a glossary of a collection of important terms or a list of words arranged alphabetically and containing short definitions.
Ferns-Info 	This feature is interesting additional information to increase your knowledge about Ferns.

Learning activities in each E-worksheet feature have been presented according to the five stages in a scientific approach.

The Validity of E-worksheet

The validity of the E-worksheet was assessed by media expert and material experts validators on three assessment aspects. Based on the validity results, it can be seen that the E-worksheet "Diversity of Ferns" is declared valid with an overall average score for the assessment aspects of 3.97 (very valid). Validity was assessed in the aspects of presentation, content, and language by getting a mean score of 3.91, 4.00, and 4.00 respectively, and was categorized as very valid for all three. These results prove that the E E-worksheet that has been developed is considered valid and suitable for use in a learning context. The validity results are presented in Table 2.

Table 2. Results of E-worksheet Validity Assessment by Experts (n=2)

No.	Assessment Aspect	Score		Average
		V1	V2	
A. PRESENTATION ASPECT				
1	Cover design of E-worksheet	4	4	4
2	Title of E-worksheet	4	4	4
3	Time allocation	4	2	3
4	Learning objectives	4	4	4
5	Instructions for using E-worksheet	4	4	4
6	Systematics of E-worksheet presentation	4	4	4
7	Page layout of E-worksheet	4	4	4
8	Image quality	4	4	4
9	Video quality	4	4	4
10	Features of E-worksheet	4	4	4
11	Accessibility of E-worksheet	4	4	4
Average of Presentation Aspect				3,91
Interpretation				Very Valid
B. CONTENT ASPECT				
12	Suitability of Material to Concept	4	4	4
13	Suitability of E-worksheet with Scientific Approach Steps			
	suitable to the Observing step in the Ferns-Observing feature	4	4	4
	suitable to the Asking step in the Ferns-Asking feature	4	4	4
	suitable to the Collecting Data step in the Ferns-Exploring feature	4	4	4
	suitable to the Associating step in the Ferns-Associating feature	4	4	4
	suitable to the Communicating step in the Ferns-Communicating feature	4	4	4
14	Suitability of E-worksheet with Critical Thinking Skills			
	practice Interpretation skills	4	4	4
	practice Analysis skills	4	4	4
	practice Evaluation skills	4	4	4
	practice Explanation skills	4	4	4
Average of Content Aspect				4
Interpretation				Very Valid
C. LINGUISTIC ASPECT				
15	Language Use	4	4	4
16	Suitability of Sentences with *Pedoman*	4	4	4

No.	Assessment Aspect	Score		Average
		V1	V2	
	Umum Ejaan Bahasa Indonesia (PUEBI)			
Average of Linguistic Aspect				4
Interpretation				Very Valid
Overall Average				3,97
Interpretation of the Validity of E-worksheet				Very Valid

Note:
V1 : 1st validator
V2 : 2nd validator

Based on the E-worksheet validity data above, it can be seen that the quality of good teaching material can be seen based on the validation results from the validator's assessment with a valid category (Suheriyanto, et al., 2014). The validity score proves that E-worksheet has fulfilled the assessment aspect components very well, making students motivated to carry out learning. This is by research conducted by Puspita & Dewi (2021), where using attractive E-worksheet can increase interactivity in learning and motivate students to learn better.

The presentation aspects assessed include several aspects such as the E-worksheet cover design, E-worksheet title, time allocation, instructions for use, learning objectives, page layout, systematic presentation, image quality, video quality, E-worksheet features, and accessibility. Time allocation received an average score of 3.00 (valid). Based on the comments and suggestions obtained, it is necessary to pay attention to the time allocation in designing the E-worksheet. It is important to pay attention to the appropriate time allocation to complete learning activities and materials. This must be adjusted to the effective number of weeks available and the time allocation that has been determined for each subject per week, as well as adjusting to learning outcomes, depth of material, level of difficulty, and learning interests (Bariyah, 2019). The assessment of the time allocation aspect was also shown by students' positive responses of 90% (very good). Most students assess that the time allocation is sufficient to carry out the learning activities provided.

According to Putra & Agustina (2021), a good E-worksheet contains aspects of good presentation, this can be known through the validation results obtained. E-worksheet is prepared by paying attention to appearance such as design, proportional layout, and neatly arranged content components so that the appearance of E-worksheet is attractive. Ningsih & Utami (2022), stated that a good E-worksheet appearance gives a good impression to readers or users. The E-worksheet was developed through the Liveworksheets site which has the advantage of its features, one of which is being able to create your answer column which can be typed directly in the column created, therefore by converting the student workheet to electronic it will make it more interesting.

The Liveworksheets that are developed can also be used or accessed online easily using an internet connection via electronic devices such as cellphones, tablets, laptops, or computers. According to Ai'syah, et al., (2022), good accessibility can make E-worksheet more effective and efficient by accessing it using a gadget or electronic device that is connected to a stable internet network for smoothness during the learning process. Apart from that, the link and QR Code provided in it has adapted the concept. This is in line with the opinion of Ghofur (2022), that the addition of links and QR Codes to E-worksheet is one of the uses of technology and adds to the attraction of students.

The content aspect received an overall average score of 4.00 and was categorized as very valid. Assessment components include suitability of the material, suitability for scientific approach steps, and suitability for practicing critical thinking skills. There are no suggestions given by the validator regarding fern material because the material presented is based on trusted and tested reading sources. This indicates that the concepts presented do not cause misconceptions among students. Misconceptions that may arise during the learning process can influence students' understanding of new material (Nugroho, 2016), so it is very important to organize material correctly and systematically based on trusted sources (Mahmood, 2011).

To support the material presented, supporting images and videos in E-worksheet topic I and E-worksheet topic II come from examples of ferns in the surrounding environment. In E-worksheet topic II, apart from pictures and videos of commonly found plants, information is also included about species of ferns that are almost extinct. This data was obtained from various sites and news sources related to conservation, such as the International Union for Conservation of Nature (IUCN), to provide learning activities involving the creation process. It is hoped that material that focuses on creation can deepen students' understanding, encourage them to think critically, and train their abilities to solve problems related to the material being studied (Ratnasari & Eman, 2017).

The linguistic aspect obtained an overall average score of 4.00 and was categorized as very valid. The linguistic component assessment includes the suitability

of sentences with *PUEBI* and language use. The validator provides input, such as that abbreviations should not be placed at the beginning of sentences, for example, E-worksheet which should be revised to become Electronic Student Worksheet. Apart from that, writing species names must consistently follow the rules for writing scientific names, namely written in italics. Choosing the right language is the main thing in learning activities because it functions as a medium for students to understand the information written in teaching materials. Apart from that, using appropriate language also helps avoid errors in interpreting information, making it easier to understand concepts (Sihafudin, 2020). The linguistic aspect of E-worksheet plays an important role in providing ease of understanding during learning activities. One of the requirements for E-worksheet is the construction requirements regarding sentence structures that are simple, clear, not complicated, and suitability of the language for student development (Syaifuddin, 2022).

The Practicality of E-worksheet

The implementation of E-worksheet is determined from the results of observations of student activities during the learning process using E-worksheet. The average implementation of E-worksheet topic I and E-worksheet topic II was 97.08% and 97.50% respectively with very good criteria. Overall, the average implementation of E-worksheet topic I and E-worksheet topic II was 97.29% with very good criteria. The results of the implementation of E-worksheet are presented in Table 3.

Table 3. Implementation Results of E-worksheet Implementation

No.	Student Activities	Implementation of E-worksheet (%)			
		Topic I		Topic II	
		I	NI	I	NI
1	Operate E-worksheet online properly.	80	20	95	5
2	Read the learning objectives contained in the E-worksheet	95	5	85	15
3	Read the work instructions contained in the E-worksheet	95	5	90	10
4	Read articles and observe images/videos contained in the Ferns-Observing feature on E-worksheet	100	0	100	0
5	Access the link and QR code presented in E-worksheet	95	5	100	0
6	Read and answer every question presented in the E-worksheet	100	0	100	0
7	Formulate questions contained in the Ferns-Asking feature on E-worksheet	100	0	100	0
8	Collect information/observation data and write it in the observation results table contained in the Ferns-Exploring feature on E-worksheet	100	0	100	0
9	Analyze data based on the information/data that has been obtained contained in the Ferns-Associating feature on E-worksheet	100	0	100	0
10	Communicate information/data that has been obtained according to the instructions in the Ferns-Communicating feature on E-worksheet	100	0	100	0
11	Send the answers to get feedback from the teacher	100	0	100	0
12	Carrying out activities on the E-worksheet feature sequentially according to the stages	100	0	100	0
Average Percentage of Implementation (%)		97,08		97,50	
Overall Average Percentage of E-worksheet (%)		97,29			
Interpretation of E-worksheet Implementation		Very Good			

Note:
I : implemented
NI : not implemented

It can be seen that the implementation of E-worksheet is stated to be very good so the E-worksheet developed is practical to use. The implementation of E-worksheet in good student activities will influence the learning activities that have been carried out (Pratiwi & Yuliani, 2021). The learning activities contained in the E-worksheet are carried out by students as a whole, however, some activities are not carried out by several students. These activities are operating E-worksheet online, reading learning objectives, reading work instructions, and accessing links and QR codes presented on E-worksheet.

Student activities when working on E-worksheet based on Liveworksheets and accessing the links and QR codes presented in E-worksheet have increased because when operating E-worksheet topic I students still feel confused because they have never had experience in operating E-worksheet in the form of Liveworksheets. Apart from that, when using E-worksheet it can only be accessed online and connected to an internet connection, some students experience device problems or unstable networks in accessing E-worksheet. There is an increase in the operation of E-worksheet because students' understanding of each of these activities is good so students' interest in using E-worksheet increases (Mursitaningrum et al., 2019).

Other activities, namely the activity of reading learning objectives and instructions for working on E-worksheet, have decreased because when operating E-worksheet topic I, students already consider reading learning objectives to be not important and feel that they do not need to be mastered. Then when operating E-worksheet topic II, several other students thought that the learning objectives in E-worksheet topic II contained the same content as the learning objectives in E-worksheet topic I, so that when the learning activity took place students went straight to the next activity without reading the learning objectives first. Apart from that, when the learning activities were running, students' attitudes were seen that were not expected, namely that the students were chatting to themselves and not paying attention to the directions from the researcher. Naturally, students need to read the learning objectives because learning objectives are a guide to the knowledge, concepts, and skills that students are expected to complete after carrying out learning activities (Hendratmoko et al., 2017).

Most students have carried out learning activities that integrate the scientific approach stage to practice critical thinking skills of analysis, interpretation, evaluation, and explanation. Interpretation skills are trained by describing the results of observations of pictures and videos regarding the diversity of ferns. Analytical skills are trained by analyzing the classification of ferns in their four divisions. Evaluation skills are trained by assessing the credibility of statements regarding the problem of fern diversity. Explanation skills are trained by communicating the general characteristics and classification of ferns. So it can be seen that the E-worksheet "Diversity of Ferns" is practically applied to the teaching and learning process in biology lessons. The high percentage proves that the learning tools designed are feasible and practical to support the learning process (Bahri et al., 2021).

The Effectiveness of E-worksheet

The effectiveness of E-worksheet is determined by the achievement of critical thinking skills and students' positive responses. Test questions are used to measure the extent to which these skills are achieved, with seven questions assessing the critical thinking skills being trained. The average score on interpretation, analysis, evaluation, and explanation skills respectively is 94.25; 90.33; 97; and 95, all of which fall within the very good criteria. The overall average test score for the four components of critical thinking skills is 93.07, also with very good criteria. The results of achieving critical thinking skills are shown in Table 4.

Table 4. Critical Thinking Skills Test Results (n=20)

Students	Value of Each Component							
	Int	C	Ana	C	Eva	C	Eks	C
1	75	Q	67	Q	80	G	80	G
2	90	VG	93	VG	100	VG	100	VG
3	100	VG	70	Q	80	G	100	VG
4	100	VG	93	VG	100	VG	100	VG
5	100	VG	100	VG	100	VG	100	VG
6	100	VG	93	VG	100	VG	100	VG
7	90	VG	100	VG	100	VG	100	VG
8	100	VG	93	VG	100	VG	100	VG
9	100	VG	77	G	100	VG	100	VG
10	100	VG	100	VG	100	VG	100	VG
11	100	VG	93	VG	100	VG	100	VG
12	100	VG	100	VG	100	VG	100	VG
13	75	Q	70	Q	80	G	80	G
14	100	VG	100	VG	100	VG	100	VG
15	90	VG	93	VG	100	VG	100	VG
16	100	VG	93	VG	100	VG	80	G
17	90	VG	100	VG	100	VG	100	VG
18	100	VG	93	VG	100	VG	100	VG
19	100	VG	93	VG	100	VG	80	G
20	75	Q	83	G	100	VG	80	G
AVR	94,25	VG	90,33	VG	97	VG	95	VG
% Students with G – VG criteria	85		85		100		100	
% Students with VL – Q criteria	15		15		0		0	

Note:
AVR: average, C: criteria, Int: interpretation, Ana: analysis, Eva: evaluation, Eks: eksplanation, VG: very good, G: good, Q: quite good, VL: very low.

The percentage of students with good to very good interpretation skills is 85%, analysis skills are 85%, evaluation skills are 100%, and explanation skills are 100%. The percentage of students with critical thinking criteria is very low to quite good in interpretation skills is 15%, analysis skills is 15%, and evaluation and explanation skills at 0%.

The results of working on seven questions on the critical thinking skills test show that 85% of students have interpretation skills in the good to very good category. The high percentage of students' interpretation skills in the good to very good category is because when learning takes place, 60% of the activities in E-worksheet focus on interpretation skills. The Diversity of Ferns trains interpretation skills. The main aspect that is important to pay attention to in training students' critical

thinking skills is the ability to make interpretations so that students can provide feedback and convey observations of objects after learning activities (Agnafia, 2019).

There were three students with interpretation skills in the very low and quite good categories. This is because students cannot interpret the general characteristics of ferns based on pictures and explain the results of observations. Another cause is that students are less involved in carrying out E-worksheet activities and encounter problems when trying to scan the QR Code of a picture of a fern, as a result, it affects the results of the interpretation test. Students' inactivity during learning activities results in low interpretation abilities because they are not fully involved in activities to find solutions to problems and redescribe the results of solving problems (Fakhriyah, 2014).

Students with analytical critical thinking skills are categorized as good to very good, worth 85%. Students can analyze the different characters of the four species of ferns, then classify them into the same group and provide an accurate analysis of the role of ferns in the surrounding environment. According to Agnafia (2019), good analytical skills in students are characterized by the skills to analyze problems encountered and find appropriate strategies to deal with them. The percentage of students with sufficient analytical skills is 15%. Students are still unable to relate the problems presented in the questions to the material being studied. If students' analytical skills are low, it is necessary to increase their ability to analyze problems and provide clear answers based on truth with evidence and logical explanations (Wahyudi, et al., 2020).

Students with evaluation and explanation skills are categorized as good to very good with a score of 100%. This shows that students can explain what they have found, students can justify reasons based on evidence, concepts, and logical methodology, and are supported by strong opinions (Facione, 2015). Students have evaluation skills by assessing the credibility and relationship of problems and issues related to diversity of ferns correctly. Students have explanatory skills by producing solutions to ferns diversity problems related to the correct material. This is relevant to the activities in E-worksheet, namely that students are directed to explain the general characteristics and classification of ferns as well as the efforts initiated on the problem of fern diversity in the form of posters and power points.

The results of achieving critical thinking are supported by constructivist learning theory. According to constructivist learning theory through Jean Piaget's ideas, adolescents aged over 11 years to adulthood have their cognitive or thinking development at the normal operational stage where their thinking abilities are abstract, their way of reasoning is logical and they can conclude from existing information (Alhaddad, 2012).

The effectiveness of the E-worksheet is also assessed based on students' positive responses regarding the E-worksheet Diversity of Ferns based on a scientific approach. Student responses are obtained by filling out a questionnaire response by 20 students after learning with E-worksheet. The average results obtained in the aspects of presentation, content, and language respectively were 98.46%, 98%, and 100% with very good criteria. The overall average result of these three aspects was 98.82% with very good criteria. The results of student responses are contained in Table 5.

Table 5. Student Responses to Implementation E-worksheet (n=20)

No.	Assessment Aspect	Percentage (%)	
		Yes	No
A. PRESENTATION ASPECTS			
1	The E-worksheet cover design is attractive	100	0
2	The E-worksheet title describes the contents of the E-worksheet	100	0
3	The type and size of letters on the E-worksheet are appropriate	95	5
4	The time allocation given is in accordance with learning activities	90	10
5	Instructions for using E-worksheet are easy to understand	100	0
6	The images in the E-worksheet support understanding of the material	100	0
7	The videos in E-worksheet display clear audio and visuals	100	0
8	The layout of the E-worksheet is arranged neatly	100	0
9	Activities on E-worksheet are arranged sequentially	100	0
10	The components of E-worksheet are interconnected and there is a connection	100	0
11	E-worksheet can be operated easily	100	0
12	E-worksheet provides a column for filling in answers directly	100	0
13	Multimedia designs (videos, hyperlinks, QR codes) in E-worksheet can be accessed	95	5
Average Percentage of Presentation Aspect (%)		98,46	
Interpretation		Very Good	
B. CONTENT ASPECT			
14	E-worksheet is appropriate to the material taught	100	0
15	E-worksheet makes it easier to understand the material and master the concepts	100	0
16	E-worksheet guides scientific activities such as observing, asking questions, gathering information, associating, and communicating	100	0

No.	Assessment Aspect	Percentage (%)	
		Yes	No
17	E-worksheet trains critical thinking skills such as interpreting, analyzing, evaluating, and explaining	100	0
18	Activities in E-worksheet are easy to do	90	10
Average Percentage of Content Aspect (%)		98	
Interpretation		Very Good	
C. LINGUISTIC ASPECT			
19	The language used is easy to understand	100	0
20	The language used is unambiguous	100	0
Average Percentage of Linguisctic Aspect (%)		100	
Interpretation		Very Good	
Overall Average Percentage (%)		98,82	
Interpretation of Student Responses		Very Good	

The E-worksheet product is considered attractive, easy to use, makes students motivated and active in learning, and makes it easier to understand the material. According to Ulfah et al.,(2013), students' learning activities are more interesting, active, creative, and enjoyable due to the availability of appropriate teaching materials. The presentation aspect has an average percentage of 98.46%, a very good criteria. Regarding the presentation of E-worksheet, the student response results were very good, which means that presentation has a very important role in the process of using E-worksheet (Setiana & Nuryadi, 2021).

The percentage of students who gave negative responses to the aspect of assessing the type and size of letters was 5% because students did not try to enlarge the screen display so that the size of the letters did not appear clear. Meanwhile, the font type and size components in the validity assessment obtained a very valid category. The type and size of letters need to be adjusted to writing standards when developing learning tools. Adjusting the type and size of letters aims to minimize the risk of learning difficulties and make it easier to absorb information on E-worksheet (Nuryasana & Desiningrum, 2020).

In the assessment aspect of the time allocation given, there was a negative response from 10% of students, students assessed that the time allocation given was not appropriate. E-worksheet has been revised based on the results of the review after receiving a validity assessment on the aspect of time allocation given. However, the positive response of students was much more dominant at 90%, so the time allocation given was considered to be by learning activities. Students also gave negative responses to multimedia design aspects (video, hyperlinks, and QR codes) by 5%. Interference with the device used and internet connection when using E-worksheet causes students to give negative responses to this statement.

The content aspect received an average percentage of 98% with very good criteria. However, in the content aspect, there was also a negative response from students of 10% to the statement that the activities in the E-worksheet were easy to do. This is because when researchers describe the stages of carrying out activities in E-worksheet, students talk with friends so that students cannot carry out activities in E-worksheet and need further direction. Some students have low ability to operate E-worksheet and some students experience problems due to internet network problems. Improvements that can be made are by improving and getting used to the use of E-worksheet in learning to increase the use of technology. This is consistent with the fact that E-worksheet is designed as an innovative digital teaching material to meet the demands of the current global era in terms of advances in information technology (Rahayu et al., 2021).

The linguistic aspect with the highest average percentage was 100% (very good). All students gave positive responses indicating that the language in E-worksheet was easy to understand and did not create double meanings. The linguistic aspect of E-worksheet plays an important role in providing ease of understanding while carrying out learning activities. Correct use of language supports students in understanding implied meanings so that it does not lead to double understanding (Syamsi & Fithrihidajati, 2021).

Student activity at each stage of learning is needed so that students gain new knowledge that can be used in practicing critical thinking skills (Sudarsana, 2020). Students also commented on the E-worksheet Diversity of Ferns, such as that the E-worksheet is very innovative because it is accessed via the Liveworksheets site, and makes it easier for students to explore the Ferns Diversity.

CLOSING

Conclusion

The E-worksheet “Diversity of Ferns” based on a scientific approach is suitable for training students' critical thinking skills, this is proven by the validity of the E-worksheet being declared valid based on expert validation assessments on aspects of presentation, content, and language with very valid criteria,

practicality E-worksheet being declared practical based on the implementation of E-worksheet with very good criteria, and the effectiveness of E-worksheet being declared effective based on the achievement of critical thinking skills of interpretation, analysis, evaluation, and explanation as well as students' positive responses with very good criteria.

Suggestion

Researchers suggest that in implementing E-worksheet a more appropriate time allocation is needed to introduce the Liveworksheets site and how to operate E-worksheet to students before using E-worksheet which was developed so that students can more easily understand the learning process using new teaching materials.

Acknowledgment

The researcher expresses his thanks to Dr. Raharjo, M.Sc., and Dr. Novita Kartika Indah, S.Pd., M.Si. who have carried out validity assessments and provided input on the E-worksheet. Thanks are also addressed to the biology teacher, Mrs. Nur Diana Maulida, S.Pd., who has provided direction, and the students of class X-1 MAN 2 Gresik who are willing to participate and provide responses to the E-worksheet "Diversity of Ferns" that was developed.

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