

APPLICATION OF ELECTRONIC-STUDENT WORKSHEETS BASED ON A SCIENTIFIC APPROACH TO TRAIN STUDENTS' CRITICAL THINKING SKILLS OF BRYOPHYTES MATERIAL

Penerapan Elektronik-Lembar Kerja Peserta Didik (E-LKPD) Berbasis Pendekatan Saintifik Untuk Melatih Kemampuan Berpikir Kritis Siswa Materi Lumut

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Abstract

Critical thinking is an essential skill that students must have in the 21st century. The scientific approach is able to train students to think critically. This research aims to describe the implementation of E-LKPD based on a scientific approach, implementation of learning, students' critical thinking skills, and students' responses. This research is referred to as quasi-experimental research. In this research, a "one group pre test and post test design" was used. The sampling process was carried out using a purposive sample technique. A total of 69 students in classes X IPA 2 and X IPA 3 were the research samples. The data collection techniques used are implementation observation techniques, test techniques, and questionnaire techniques. Data analysis was carried out by analyzing research instruments, namely learning implementation sheets, improving students' critical thinking skills, and analyzing student responses to learning implementation. The essential indicators of thinking that are trained are interpretation, analysis, and explanation—increased student learning outcomes from pre-test to post-test with average N-Gain scores for classes X IPA 3 and X IPA 2 respectively of 0.87 and 0.85 in the high category. The implementation of learning with E-LKPD based on a scientific approach in classes X IPA 2 and the implementation of E-LKPD obtained an average percentage of 100%, which shows that student activity when participating in learning using E-LKPD is categorized as very practical for training students' critical thinking skills. Student responses respectively obtained a response percentage of 95% and 94% in the outstanding category.

Keywords: scientific approach, critical thinking skills, bryophytes.

Abstrak

Berpikir kritis merupakan keterampilan penting yang harus dimiliki siswa di abad ke-21. Pendekatan saintifik dinilai dapat melatih peserta didik untuk berpikir kritis. Penelitian ini bertujuan untuk mendeskripsikan keterlaksanaan E-LKPD berbasis pendekatan saintifik, keterlaksanaan pembelajaran, keterampilan berpikir kritis siswa dan respons siswa. Penelitian ini disebut sebagai penelitian eksperimen semu. Dalam penelitian ini, digunakan "one group pre test and post test design". Proses pengambilan sampel dilakukan dengan menggunakan teknik purposive sample. Sebanyak 69 siswa di kelas X IPA 2 dan X IPA 3 menjadi sampel penelitian. Teknik pengumpulan data yang digunakan yaitu teknik observasi keterlaksanaan, teknik tes, dan teknik angket. Analisis data dilakukan dengan menganalisis instrumen penelitian yaitu lembar keterlaksanaan pembelajaran, analisis peningkatan kemampuan berpikir kritis siswa dan analisis respon siswa terhadap pelaksanaan pembelajaran. Indikator berpikir kritis yang dilatihkan yaitu interpretasi, analisis, dan eksplanasi. Peningkatan hasil belajar siswa dari pre test ke post test dengan rerata nilai N-Gain kelas X IPA 3 dan X IPA 2 berturut turut sebesar 0,87 dan 0,85 dengan kategori tinggi. Keterlaksanaan pembelajaran dengan E-LKPD Berbasis Pendekatan Saintifik pada kelas X IPA 2 dan X IPA 3 berturut turut dengan rerata persentase 95% dan 98% yang menunjukkan kategori sangat baik. Keterlaksanaan E-LKPD memperoleh rerata persentase 100% yang menunjukkan aktivitas siswa saat mengikuti pembelajaran dengan menggunakan E-LKPD yang dikategorikan sangat efektif untuk melatih kemampuan berpikir kritis siswa. Respons siswa berturut turut memperoleh persentase respons sebesar 95% dan 94% dengan kategori sangat baik.

Kata Kunci: pendekatan saintifik, kemampuan berpikir kritis, lumut

INTRODUCTION

The development of the 21st century in various fields is running very rapidly, such as technology and education. Education is becoming increasingly important in the 21st century. Student-centered learning is a system applied to the 2013 Curriculum learning so that students are more active and creative. Although it is anticipated that the 2013 Curriculum will apply learning through a scientific method, a large portion of education is still teacher-centered and solely concentrates on the teacher. As a result, 21st-century skills still need to be mastered optimally by students (Redhana, 2019).

The 4C is communication, creativity, cooperation, and critical thinking are 21st-century qualities that students must acquire in order to meet the challenges of the twenty-first century (Scott, 2015). The demands that must be possessed in 21st-century skills by learners are critical thinking or critical thinking. The 2013 curriculum has one of the objectives, namely training students' critical thinking skills through the learning stage (Ministry of Education and Culture, 2018). Students must have skills and also be able to solve a problem using a critical thinking process (Rahman, 2019).

Critical thinking is the process of gradually connecting information step by step with information that is already owned before, which can be called analytical thinking. The ability to think critically can make students more active because it frees students to ask questions and give feedback or criticism about information that students want to know (Saleh, 2019).

Education in Indonesia is ranked 40 out of 40 countries surveyed in the world, where the ranking is at the bottom according to the results of the 2012 Global Index of Cognitive Skills and Educational Attainment overall (Srie, 2013). The difference in the results of the TIMSS (The Trends in International Mathematics and Science Study) survey results is that in Taiwan cl, close to 50% of students are able to answer high-level questions. In comparison, 95% of students in Indonesia are only able to solve middle-level questions. Based on this information, it can be concluded that the level of critical thinking skills of students in Indonesia is still inadequate. Therefore, it is necessary to develop critical thinking skills by applying learning methods that are suitable for them. One method that is suitable for students is the scientific approach.

The scientific approach is a learning stage that can lead students to activities like science scientists so that students can solve problems with careful planning activities, collect data carefully, analyze data carefully,

and trigger a conclusion. The scientific approach directs students to think critically, systematically, and creatively so that students are active in constructing laws, concepts, or principles (Pahrudin & Pratiwi, 2019). Students who are able to solve problems, ask questions, analyze data or information from various sources, and are proficient in communicating with others are the goals of a scientific approach to increasing students' critical thinking potential (Kusumah, 2019). The scientific approach is considered important in learning because it can improve various skills. Several abilities can be improved, such as the ability to think critically, communication skills, collaboration and research, and character behavior. This is because learning experiences are indispensable in solving problems in everyday life (Machin, 2014).

Critical thinking abilities can be developed through innovation through the application of teaching materials founded on a methodical scientific understanding of learning. In accordance with the opinion that innovation and variety are needed in the learning process, student worksheets learning media are one way to strengthen one's capacity for critical thought (Elfina & Ike, 2020). The advantage of electronic student worksheets learning media is that students can be accommodated independently in process discovery or in conducting experiments. Student worksheets can also help educators control the course of learning in class, and students can understand concepts and trigger their curiosity in their way (Mursyidin, 2019). The presentation of student worksheets has developed along with development time, and it has now been able to be linked through electronic-based media known as student worksheets (Adilla et al., 2017). An electronic student worksheet is an interactive teaching material that contains and presents simulations in the form of text, animation, video, and images and is supported by guidelines that make students understand more and learning meaningful (Lathifah et al., 2021).

Based on observations at SMA Muhammadiyah 1 Taman, the only learning media used is student worksheets, which use paper. This statement is in accordance with Elfina and Ike's (2020) research that student worksheets applied to learning in schools only contain a summary of material with blurry images, which makes it less attractive to students. Efforts can be made to increase student motivation and train students' critical thinking skills by applying electronic student worksheets.

The electronic student worksheet developed by Marufah has the advantage of being easily accessible via the internet or online, and it has features that can train critical thinking skills through a scientific approach. After being tested on 15 children, they received very

satisfactory results, namely the results of the student worksheets bryophytes validation test, which was 3.88 (very valid), the results of the student worksheets bryophytes topic one and topic two practical test, which were 99.05% and 100% (efficient), the results of the student worksheets validation test, which was 3.88 (very valid), and student worksheets to train critical thinking interpretation indicators, Analysis and explanation sustainably amounted to 80%, 73.33%, and 86.67%, and the percentage of positive responses from students amounted to 95.10% (perfect). Based on the provided data, Marufah's prepared student worksheets is deemed appropriate for implementation in biology lessons for high school students in class X. This conclusion takes into account various factors, including user-friendliness, validity, and efficacy. The examination also revealed that 86.67% of students demonstrated a high level of critical thinking in their explanation of the content. In comparison, interpretation skills reached 80%, and analysis reached 73.33%. The advantages of electronic student worksheets, in general, contain a summary of material containing visual, text, and audio elements, containing questions and implementation instructions in accordance with the essential competencies that teachers and students want to achieve (Awe & Ende, 2019).

Critical thinking skills are needed in biology, for example, in bryophytes. Bryophytes material is found in KD 3.8, which relates the role of these plants to everyday life and groups plants into division degrees based on general characteristics, and KD 4.8, namely the role of plants in everyday life and the presentation of reports from observations and phylogenetic and phenetic analysis of plants that have been carried out. Plant diversity material is in class X Biology and is a material that is considered to have a relatively high level of difficulty because the material requires insights related to special characters, how to adapt, structure and arrangement, habitat, and how to reproduce; this knowledge will be used for the classification or division chapter (Fransisca et al., 2016). (Wartiningsih et al. 2016) They also argue that plant diversity is part of biology learning material that instills critical thinking skills in students. The scientific approach is one method that is able to train critical thinking skills in students because critical thinking skills in students are critical to be trained.

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knowledge will be used for the classification or division chapter (Fransisca et al., 2016). (Wartiningsih et al. 2016) They also argue that plant diversity is part of biology learning material that instills critical thinking skills in students. The scientific method is one that can help pupils develop their critical thinking abilities since it is essential that they be taught.

The purpose of this study is to provide an overview of how electronic student worksheets are used to implement learning based on a scientific approach to learning moss biology at SMA Muhammadiyah 1 Taman. Describe the implementation of student worksheets in electronic format that follow a scientific method of instruction in bryophytes biology at SMA Muhammadiyah 1 Taman. Describe students' critical thinking skills after implementing electronic student workbooks with a scientific learning methodology in bryophytes biology at SMA Muhammadiyah 1 Taman. Describe students' responses to student worksheets in electronic format that follow a scientific method of instruction in bryophytes biology at SMA Muhammadiyah 1 Taman.

METHOD

Quasi-experimental research was applied with the aim of determining the effects of treatment without using a control or comparison class. The treatment in question is the application of an electronic student worksheet based on a scientific approach. This research is quantitative in the form of implementing a treatment in the classroom. This experimental research method can be interpreted as a research method applied to search for the effect of a specific therapy on students under controlled conditions.

A one-group pretest and posttest design was used for the pre-experimental design in order to measure the improvement in student learning outcomes. Pretest questions were given during the learning process prior to utilizing e-LKPD, and posttest questions were given during the learning process following the use of e-LKPD. By using identical pretest and posttest questions, this attempts to ensure that the outcomes of the treatment can be more accurately determined by comparing the cognitive level of students prior to the implementation of e-LKPD (treatment). This is how the design can be explained:

Tabel 1 One Group Pretest and Posttest Design

Procedures		
O ₁	X	O ₂
O ₃	X	O ₄

Description :

- O₁ : Pre-test results of X Science 2
O₂ : Post-test results of X Science 2
O₃ : Pre-test results of X Science 3
O₄ : Pre-test results of X Science 3

The target of this research is an electronic student worksheet to train critical thinking skills on the bryophytes sub-material for 34 students of class X Science 2 and 35 students of class X Science 3 SMA Muhammadiyah 1 Taman. The data collection techniques used in this research are questionnaire techniques, implementation observation techniques, and test techniques. The data analysis technique used in this research is descriptive-quantitative analysis, where research data is described and presented according to the data obtained.

The research parameters include the implementation of learning, the implementation of electronic student worksheets, critical thinking ability tests, and positive student responses. The implementation of learning was obtained using an implementation observation instrument consisting of 26 aspects at the first meeting, 18 aspects at the second meeting, and 9 aspects at the third meeting. Obtained from three observers. Scoring the observation sheet uses the Guttman scale guidelines, namely a score of 1 (implemented) and 0 (not implemented). The percentage score obtained from each aspect is calculated and then implemented using practical criteria: 0%-20% (not good), 21%-40% (not good), 41%-60% (reasonably good), 61%-80% (good), and 81%-100% (efficient) (Riduwan, 2012).

The implementation of an electronic student worksheet was obtained using an implementation observation instrument consisting of 15 aspects obtained from three observers. Scoring the observation sheet uses the Guttman scale guidelines, namely a score of 1 (implemented) and 0 (not implemented). The percentage of scores obtained from each aspect is calculated and then implemented using practicality criteria: 1%-48% (not practical), 49%-61% (less practical), 62%-74% (reasonably practical), 75%-87% (practical), and 88%-100% (efficient). The Electronics Student Worksheet is declared practical if the percentage of implementation is $\geq 75\%$ (Riduwan, 2012).

The critical thinking ability test is obtained from five questions, namely two interpretation indicator questions, two analysis indicator questions, and one explanation indicator question. The results of the critical thinking ability test in the form of scores are categorized according to the Likert Scale (2021): 0%-40% (not good), 41%-55% (not good), 55%-70% (reasonably

good), 71%-85 % (good, and 86%-100% (perfect). The Electronics Student Worksheet is declared effective if the percentage of students who obtain good to perfect criteria for critical thinking ability indicators is $\geq 71\%$ (Riduwan, 2016).

Student responses were obtained from a 10 item questionnaire from 69 Muhammadiyah 1 Taman High School students. The score for each question uses the Guttman scale, namely a score of 1 (Yes) and 0 (No). The percentage score obtained for each item is calculated and then categorized using the following criteria: 0%-20% (not good), 21%-40% (not good), 41%-60% (reasonably good), 61%-80% (good), and 81%-100% (perfect) (Riduwan, 2012).

RESULTS AND DISCUSSION**1. Implementation of learning**

Implementation of learning in class X IPA 2 with worksheets based on a scientific approach to practice the critical thinking skills of students, Bryophytes material produces an average percentage of 95%, which shows very good categories in the skills of teachers to manage learning using scientific-based worksheets. The assessment carried out by three observers during three meetings fulfilled almost all aspects except for the teacher directing students to scan QR codes, reminding students of previous material, and making conclusions.

Table 2. Interpretation of the implementation of class X Science 2 learning with the worksheets

Observed Aspects	Implementation								
	1 st meet			2 nd meet			3 rd meet		
	O1	O2	O3	O1	O2	O3	O1	O2	O3
Total	25			16			9		
Percentage (%)	96			89			100		
Average (%)	95								
Category	Very Good								

Description :

- O1: Observer 1
O2: Observer 2
O3: Observer 3

The practicality of worksheets in terms of the implementation of learning with worksheets based on a scientific approach to train students critical thinking skills bryophytes material with an average percentage of 98%, which shows an outstanding category in teacher skills in managing learning using scientifically-based worksheets. The assessment conducted by three observers during three meetings fulfilled almost all aspects except for the teacher aspect, directing students to scan QR codes, reminding students of previous material, and making conclusions.

Table 2. Interpretation of the implementation of class X Science 3 learning with the worksheets

Observed Aspects	Implementation								
	1 st meet			2 nd meet			3 rd meet		
	O1	O2	O3	O1	O2	O3	O1	O2	O3
Total	26			17			9		
Percentage (%)	100			94			100		
Average (%)	98								
Category	Very Good								

Description :

O1: Observer 1

O2: Observer 2

O3: Observer 3

The learning implementation test resulted in an overall average score from the first, second and third meetings in class X Science 2 of 95% in the very good category. This feasibility test did not get the maximum score because there were deficiencies in implementing the learning at the first meeting; namely, the teacher did not direct the students and their groups to scan the QR Code provided in the electronic student worksheets. The second meeting, namely the teacher should have reminded the students of the previous material. The teacher does not direct students and their groups to scan the QR code because the students have independently scanned the QR Code listed on the Electronic Student Worksheet, and the teacher does not remind students of the previous material because they remember the learning time limit at Muhammadiyah High School. 1 The time is quite limited, so the teacher immediately started learning without reviewing the previous material. Meanwhile, class X IPA 3 produced an average of 98%. This feasibility test did not get the maximum score because there were deficiencies in implementing the learning at the second meeting; the teacher should have reminded students of the previous material. This is because considering that the learning time limit at SMA Muhammadiyah 1 Taman is quite limited, the teacher immediately started learning without reviewing the previous material. The implementation of learning is

observed to see the suitability between learning activities carried out by teachers and strategies in learning based on assessment for learning (Dini & Muchlis, 2022). Learning implementation is data about the teacher's achievements in teaching activities in the classroom. Learning is said to run well if all aspects can be fulfilled

2. Implementation of worksheet

Results of Implementation of Interpretation of the implementation of class X Science 2 learning with the worksheets based on a Scientific Approach to the Biology Learning in the Classroom X IPA 2. Bryophytes material for critical thinking skills. Calculated so as to obtain results and be interpreted in Table 4.

Table 4. Interpretation of the Implementation of Scientific-based worksheets in Class X Science 2 Learning

Observed Aspects	Implementation		
	P1	P2	P3
Total	15	15	15
Percentage (%)	100	100	100
Average (%)	100		
Category	Very Effective		

Description :

O1: Observer 1

O2: Observer 2

O3: Observer 3

Based on Table 4, Utilizing electronic student worksheets with a scientific methodology in X Science 2 classrooms to develop students' critical thinking abilities on moss material with an average of 100%, which shows student activity X Science 2 when participating in studying using student electronics worksheets, which are classified as student electronics worksheets that are very effective in developing students' critical thinking abilities X Science Two.

Results of the implementation of worksheets based on a scientific approach to classroom biology learning X IPA 3 bryophytes material for critical thinking skills. calculated so as to obtain the results and be interpreted in Table 5.

Table 5. Interpretation of the Implementation of Scientific-based worksheets in Class X Science 3 Learning

Observed Aspects	Implementation		
	P1	P2	P3
Total	15	15	15
Percentage (%)	100	100	100
Average (%)	100		
Category	Very Effective		

Description :

O1: Observer 1

O2: Observer 2

O3: Observer 3

Based on Table 5, the Implementation of Electronic Student Worksheets based on a scientific approach to train students' critical thinking skills on bryophytes material with an average of 100%, which shows the activity of class students X IPA 3 when following learning using the Electronics of Student Worksheets, which is categorized as Electronics of Student Worksheets very effective in improving critical thinking skills.

Implementing electronic student worksheets in classes X Science 2 and X Science 3 resulted in an average score of 100% in the very effective category. This shows that all aspects of electronic student worksheets have been implemented well and that the use of electronic student worksheets in learning has had a very good impact on students. The application of electronic student worksheets in learning makes learning easier to support student learning outcomes. Using a learning model based on a scientific approach assisted by electronic student worksheets is a learning program designed to assist teachers in optimizing student learning in training the ability to think scientifically and systematically.

3. Students Critical Thinking Skills

The effectiveness of the electronic student worksheets based on a scientific approach is also seen from the increase in student learning outcomes and the completion of test item indicators. Student learning outcomes were obtained through pre-test and post-test work on bryophytes material. Student learning outcomes are in the form of cognitive learning outcomes consisting of pre-test and post-test. The level of success in students' critical thinking can be seen in each critical thinking indicator measured in this research.

Table 6. Student Results (n=69)

No.	Criteria For Achieving Learning Objectives	Measured Critical Thinking Indicators	Result (%)	
			Pre test	Post test
1.	Presenting Bryophytes and not Bryophytes pictures, students can differentiate correctly and mention the reasons with minimum of 2 characteristics.	Interpretation	12	96
2.	Presenting a statement about Bryophytes characteristics,	Interpretation	43	84

No.	Criteria For Achieving Learning Objectives	Measured Critical Thinking Indicators	Result (%)	
			Pre test	Post test
	students are requested to determine the correct characteristics by drawing the Bryophytes with its information of parts.			
3.	Presenting a picture, students can mention the Bryophytes species name and explain its characteristics correctly.	Explanation	36	85
4	Presenting a Bryophytes phenogram, students can analyze it.	Explanation	62	95
5	Presenting 3 pictures of Bryophytes, students can mention their types and analyze why they are categorized as Bryophytes.	Analysis	40	100

The interpretation of the percentage of students classified as complete, both pre-test and post-test, was determined by the N-gain score and the results obtained in Table 7.

Table 7. Students Pre-test and Post-test Interpretation

Observed Ascpets	Implementation
Completed Students	100%
Pre-test Average	39,058
Post-test Average	92
N-gain score Average	0,87

Taking the pre-test resulted in an average of 39.058. Meanwhile, the post-test resulted in an average score of 92. The average N-Gain score for the high group was 0.87, and the overall achievement of the students who scored higher than KKM 75 was 100%. As a result, the learning outcomes of the students increased from the pre-test to the post-test. Using electronic student worksheets focused on a Scientific Method to develop students' critical thinking on bryophytes material can improve students' learning outcomes, according to the learning outcomes of the students.

Critical thinking is the ability to reason regularly and systematically to find solutions to problems, make

decisions, and express beliefs accompanied by evidence. Critical thinking skills can also be used to apply information that has been received and process and evaluate things that are not appropriate (Zubaidah, 2017). Critical thinking skills need to be trained through learning methods that are appropriate and interesting for students. Applying electronic student worksheets based on a scientific approach to most material is a solution to overcome the problem of students' low critical thinking skills. This research is reviewed based on the effectiveness of electronic student worksheets in training students' critical thinking skills.

Overall, student learning outcomes are complete, with an average post-test score of 92, which is above the KKM score. Based on this average value, it can be interpreted that students understand the submaterial of bryophytes. The learning results obtained by students show a relationship between completeness in post-test work and activeness during learning activities observed during learning by observers. Student learning outcomes can be achieved if they participate in participatory learning activities (Risanatul & Junaidi, 2022).

The increase in student constructivism learning outcomes is calculated using N-gain. With an average n-gain value of 0.87, the result was classified as high. The n-gain number demonstrates how well students' critical thinking abilities may be trained in the high category using the scientifically grounded electronic student worksheet. Additionally, this score shows that pupils' learning outcomes have significantly increased. Based on scientific research, E-LKPD has been shown to enhance student learning outcomes when compared to typical pre- and post-test results (Zahroh & Yuliani, 2021).

Through observation and analysis of post-test questions, students get the ability to analyze photographs with and without moss using scientific knowledge. Competence in observing requires students to use their five senses to obtain information that fosters curiosity so that they gain new knowledge and become meaningful learners that can be stored in long-term memory (Diani, 2016). Post-test questions are numbers 1 and 2, and activities that develop these skills can be found in the Let's Observe feature. First question's average post-test score percentage is 96%, while second question's average post-test score percentage is 84%. The rate of post-test scores for question number 2 is lower and relatively low compared to the other scores because students still need to specifically remember and understand the differences in moss based on the characteristics presented in the post-test questions. However, this score supports the idea that the Let's Observe feature can train critical thinking

and interpretation skills. Therefore, a scientific-based electronic student worksheet is effective in training interpretative essential skills of thinking.

Students' ability to explain can be measured from pre-test and post-test questions number 3 and 4 in the Let's Reason feature. The average score percentage on question number 3 has increased from the pre-test score of 36% and the post-test score of 85%. Still, the percentage of post-test scores on question number 3 is lacking. It is classified as low among the other scores because students still do not specifically remember and understand the differences in bryophytes based on the characteristics presented in the post-test questions. The average percentage score on question number 4 has increased from the pre-test score of 62% to the score post-test of 95%. Explanation skills are trained through questions based on classifying and analyzing phenograms. Students' ability to explain can be measured from pre-test and post-test question number 5 in the Let's Observe feature. The average score percentage has increased from the pre-test score of 40% and the post-test score of 100%.

Constructivism theory is the applicable learning theory that the scientifically based electronic student worksheet is in line with since the percentage rise in the average post-test score from the pre-test has grown. Constructivism theory has the principle that knowledge is built through students' activities in understanding basic concepts, understanding and applying procedural knowledge, then interpreting, synthesizing information, and being able to communicate the knowledge they have obtained to reason personally and socially (Pudjiastuti, 2007). Therefore, a scientific-based electronic student worksheet can train critical thinking skills.

4. Student's Responses to Scientific based electronic student worksheet in Class for Bryophytes Material

The effectiveness of electronic student worksheets is seen from the results of positive responses from student response questionnaires to learning with electronic student worksheet bryophytes based on a scientific approach. A summary of the calculation of students' positive responses to electronic student worksheet bryophytes is presented in Table 8.

Table 8. Student responses (n=69)

No.	Criteria	Positive Response (%)	Negative Response (%)	C
1.	Biology class using scientific based electronic student	90	10	VG

No.	Criteria	Positive Response (%)	Negative Response (%)	C
	worksheets to train critical thinking skills is a new lesson for me.			
2.	Biology class using scientific-based electronic student worksheets to train critical thinking skills encourages me to be more active in class.	90	10	VG
3.	Biology class using scientific-based electronic student worksheets to train critical thinking skills interests me to study about Bryophytes.	93	7	VG
4.	Biology class using scientific electronic student worksheets to train critical thinking skills makes me better understand the materials.	97	3	VG
5.	Biology class using scientific-based electronic student worksheets to train critical thinking skills makes class not monotonous because there are lots of supporting features such as pictures, audio, and videos.	100	0	VG
6.	Biology class using scientific-based electronic student worksheets to train critical thinking skills trains me to be able to think critically.	100	0	VG
7.	Biology class using scientific-based electronic student worksheets to train critical thinking skills trains me to be able to understand.	100	0	VG
8.	Biology class using scientific-based electronic student worksheets to train critical thinking skills trains me to be able to give explanations.	88	12	VG
9.	Biology class using scientific-based electronic student	91	9	VG

No.	Criteria	Positive Response (%)	Negative Response (%)	C
	worksheets to train critical thinking skills trains me to be able to conclude.			
10.	Biology class using scientific-based electronic student worksheets to train critical thinking skills helps me to get new knowledge easier and very enjoyable.	97	3	VG
Average of All Responses		95		VG

Description :

C = Category

VG = Very Good

Based on students' positive responses to the bryophytes electronic students worksheet, 95% of positive responses were obtained in the outstanding category. A large percentage of positive student responses showed that students liked the activities presented. Electronic learner worksheets are considered attractive and easy to use. They foster student motivation and make students active in learning activities, make it easier to understand the material presented, and develop critical thinking skills.

A large percentage of positive student responses showed that students liked the activities presented in the E-LKPD. The Electronic Student Worksheet is considered attractive and easy to use. It helps students be motivated and active in learning activities, making it easier to understand the material presented. Using a scientific approach to teaching materials allows students to receive the material studied well so that student learning outcomes can improve during learning activities (Syahrir, 2019).

CLOSING

Conclusion

The results of students' critical thinking skills after implementing electronic student worksheets were based on a scientific approach to training essential skills of thinking; namely, the pre-test produced an average score of 38.5. In contrast, the post-test results resulted in an average score of 91.5. Based on this, there was an increase in student learning outcomes from pre-test to post-test with an average N-Gain score of 0.87 in the high category, and the complete achievement of students who got a score more than KKM 75 was 100%. The implementation of learning resulted in an average

percentage of 95%, which indicates an outstanding category. Implementation of Electronic Student Worksheets based on a scientific approach to train students' critical thinking skills on bryophytes material with an average score of 100%, which shows student activity when taking part in learning using categorized electronic student worksheets. Electronic student worksheets are very effective in supporting education. Based on students' positive responses to electronic student worksheets bryophytes, a positive response percentage of 95% was obtained in the outstanding category.

Suggestion

Research on the application of electronic student worksheets based on a scientific approach to train students' critical thinking skills bryophytes Material Similar research is needed in other biology learning so that the critical thinking skills of students are increasingly trained.

Based on the research results, students' critical thinking skills improve more after implementing electronic student.

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BIBLIOGRAPHY

- Agnafia, D. N. 2019. Analisis Kemampuan Berpikir Kritis Siswa dalam Pembelajaran Biologi. *Florea: Jurnal Biologi dan Pembelajarannya*. Vol. 6 (1): hal. 45-53.
- Asikin, N., Irawati, M. H., & Syamsuri, I. (2017). Pembelajaran Biologi Berpendekatan Saintifik Model Sains Teknologi Masyarakat untuk Meningkatkan Hasil Belajar Siswa. *Pedagogi Hayati*, 1(1). 1-12
- Awe, E. Y., & Ende, M. I. 2019. Pengembangan Lembar Kerja Peserta Didik Elektronik Bermuatan Multimedia untuk Meningkatkan Kemampuan Kognitif Siswa pada Tema Daerah Tempat Tinggalku pada Siswa Kelas IV SDI Rutosoro di Kabupaten Ngada. *Jurnal DIDIKA: Wahana Ilmiah Pendidikan*

Dasar,5(2):<https://doi.org/10.29408/didika.v5i2.1782>

- Bujuri, D. A. 2018. Analisis Perkembangan Kognitif Anak Usia Dasar dan Implikasinya dalam Kegiatan Belajar Mengajar. *Literasi*. 9 (1):37-50.
- Cahyono, B. 2017. Analisis Keterampilan Berfikir Kritis dalam Memecahkan Masalah Ditinjau Perbedaan Gender. *Aksioma*, 8 (1):50.
- Danoebroto, S. W. 2017. Interaksi Budaya dan Perkembangan Kemampuan Berpikir Matematis Ditinjau dari Teori Vygotsky dan Teori Bruner. *Indonesian Digital Journal of Mathematics and Education*,4(7),480–488.
http://idealmathedu.p4tkmatematika.org/articles/IME-V4.7-08_Danoebroto.pdf.
- Daryono, & Diani, R. 2016. Pengaruh Pendekatan Saintifik Berbantuan LKS terhadap Hasil Belajar Fisika Siswa Kelas XI SMA Perintis 1 Bandar Lampung. *Jurnal Ilmiah Pendidikan Fisika 'Al-BiRuNi'*. 5 (1):83-93.
- Eman, M., Sari, A. P., & Ariandi, A. 2022. Studi Keanekaragaman Lumut (Bryophyta) di Kawasan Hutan Desa Taupe, Kecamatan Mamasa, Kabupaten Mamasa, Sulawesi Barat. *Jurnal Pendidikan Biologi Undiksha*, 9(1), 85-94.
- Fachrurazi. 2011. Penerapan Pembelajaran Berbasis Masalah untuk Meningkatkan Kemampuan Berpikir Kritis dan Komunikasi Matematis Siswa Sekolah Dasar. *Forum Penelitian*, Edisi khusus 1: 76-89.
- Facione, P. A. 2013. *Critical Thinking: What It Is and Why It Counts*. California: The California Academic Press.
- Faza, Wulida M., Rahayu, Yuni S. 2023. "The Development of E-Book Based on A Scientific Aproach to Train Critical Thinking Ability on The Structure of Plant Tissue Topic". *Bioedu*. 12(3): 773-786.
- Fisher, A. 2008. Berpikir Kritis Sebuah Pengantar. Terjemahan Benyamin Hadiata. Jakarta: PT. Gelora Aksara Pratama.
- Fransisca, R., Yustina., & Fauziah, Y. 2016. The Development of Student Worksheets (LKPD) Based Sistikharahcientific Approach to Increase Critical Thinking Ability on The Subject World of Plant (Plantae) Grade X High School. *Jurnal Online Mahasiswa Fakultas Keguruan dan Ilmu Pendidikan*. 3 (2), 1-14.
- Gembong. 1999. Lakitasari, M. 2018. *Mengenal Tumbuhan Lumut (Bryophyta) Deskripsi, Klasifikasi, Potensi dan Cara Mempelajarinya*. Magetan: Ae Media Grafika.

- Insyasiska, D., Zubaidah, S., & Susilo, H. 2017. Pengaruh *Project Based Learning* terhadap Motivasi Belajar, Kreativitas, Kemampuan Berpikir Kritis dan Kemampuan Kognitif Siswa pada Pembelajaran Biologi. *Jurnal Pendidikan Biologi*. 7 (1), 9-21.
- Ismaimuza, D. 2017. Kemampuan Berpikir Kritis Matematis Ditinjau dari Pengetahuan Awal Siswa. *Jurnal Pendidikan Matematika*, 2(1).
- Istikharah, R. & Simatupang, Z. 2017. Pengembangan Lembar Kegiatan Peserta Didik (LKPD) Kelas X SMA/MA pada Materi Pokok Protista Berbasis Pendekatan Ilmiah. *Jurnal Pendidikan Matematika dan Sains*. 12 (1):1-6.
- Kusumah, R. G. T. 2019. Peningkatan Kemampuan Berfikir Kritis Mahasiswa Tadris IPA melalui Pendekatan Saintifik pada Mata kuliah IPA Terpadu. *Indonesian J. Integr. Sci. Education (IJIS Edu)*. 1 (1), 71-84.
- Lakitasari, M. 2018. *Mengenal Tumbuhan Lumut (Bryophyta) Deskripsi, Klasifikasi, Potensi dan Cara Mempelajarinya*. Magetan: Ae Media Grafika.
- Mac Kinnon, K. 1992. *Nature's Treasurehouse-The Wildlife of Indonesia*. Jakarta: PT Gramedia Pustaka Utama.
- Machin, A. 2014. Implementasi Pendidikan Saintifik, Penanaman Karakter dan Konservasi pada Pembelajaran Materi Tumbuhan. *Jurnal Pendidikan IPA Indonesia*. 3 (1), 28-15.
- Machin, A. 2014. Implementasi Pendekatan Saintifik, Penanaman Karakter dan Konservasi pada Pembelajaran Materi Pertumbuhan. *Jurnal Pendidikan IPA Indonesia*. 3 (1), 31.
- Ma'rufah, S., & Wisanti. (2023). Pengembangan Lembar kerja peserta didik-Elektronik (E-LKPD) Lumut Berbasis Pendekatan Saintifik untuk Melatih Kemampuan Berpikir Kritis Siswa. *Bio-Edu: Jurnal Pendidikan Biologi*, 12(1), 1–15.
- Novitasari, Febriana., Puspitawati, Rinie Pratiwi. 2022. Pengembangan E-LKPD Berbasis *Problem Solving* pada Materi Pertumbuhan dan Perkembangan untuk Melatihkan Keterampilan Berpikir Kritis Siswa Kelas XII SMA. *Jurnal Inovasi Pembelajaran Biologi*. 3(1): 31-42.
- Hosnan, M. 2014. *Pendekatan Saintifik dan Kontekstual dalam Pembelajaran Abad 21*. Bogor: Ghalia Indonesia.
- Nur, M & Prima R. Wikandari. 2000. *Pengajaran Berpusat kepada Siswa dan Pendekatan Konstruktivisme dalam Pembelajaran*. Surabaya: Pusat Studi MIPA Sekolah UNESA.
- Prameswari, S. W., Suharno., & Sarwanto. 2018. Inculcate Critical Thinking Skills in Primary School. *SHEs: Conference Series*. 1 (1), 742-750.
- Permatasari, E. A. 2018. Implementasi Pendekatan Saintifik dalam Kurikulum 2013 pada Pembelajaran Sejarah. *Indonesian Journal of History Education*. 3 (1), 11-16.
- Proulx, 2004. Fuad, N. M., Zubaidah, S., Mahanal, S., & Suarsini, E. 2017. Improving Junior High Schools' Critical Thinking Skills Based on Test Three Different Models of Learning. *International Journal of Instruction*. 10 (1), 101-116.
- Purnamasari, I., A, Ikrar, P., dan Ira, K. 2017. Analisis Proses Berfikir Kritis Siswa dalam Pemecahan Soal Cerita Materi Persamaan Linier Satu Variabel yang Memuat Nilai Mutlak Ditinjau dari Minat Belajar Matematika Siswa Kelas X Semester II SMA 1 Klaten Tahun Ajaran 2016/2017. *Jurnal Pendidikan Matematika dan Matematika*, 1 (2), 57.
- Rahman, M. 2019. 21st Century Skill "Problem Solving": Defining the Concept. *Asian Journal of Interdisciplinary Research*. 2 (1), 71-81.
- Ratumanan, G. T. dan Laurens, T. 2011. *Evaluasi Hasil Belajar pada Tingkat Satuan Pendidikan*. Surabaya: UNESA University Press.
- Redhana, I. W. 2010. Pengaruh Model Pembelajaran Berbasis Peta Argumen terhadap Keterampilan Berpikir Kritis Siswa Topik Laju Reaksi. *Jurnal Pendidikan dan Pengajaran*. 43 (2), 141-148.
- Rusman. 2017. *Belajar dan Pembelajaran Berorientasi Standar Pendidikan*. Jakarta: Kencana.
- Saleh, S. E. 2019. Critical Thinking as a 21-Century Skill: Conceptions, Implementation and Challenges in the EFL Classroom. *European Journal of Foreign Language Teaching*. 4 (1), 1-16.
- Samawati, Z. 2021. Profil Validitas dan Kepraktisan E-LKPD Tipe *Flipbook* Berbasis *Contextual Teaching and Learning* untuk Melatihkan Keterampilan Berpikir Kritis pada Materi Transpor Membran. *Berkala Ilmiah Pendidikan Biologi*. 10 (3), 385-396.
- Saputra, S. & Kuntjoro, S. 2019. Keefektifan Lembar Kegiatan Siswa Berbasis *Problem Based Learning* pada Materi Perubahan Lingkungan untuk Melatihkan Keterampilan Berpikir Kritis. *Berkala Ilmiah Pendidikan Biologi*. 8 (2), 291-297.
- Sarah, A. 2023. Studi Analisis Pola Pengelompokan Tumbuhan Paku Sejati (Polypodiopsida) dari Kawasan Gunung Galunggung Berdasarkan Data Fenetik dan Filogenetik Secara In Silico. (Doctoral dissertation, Universitas Siliwangi).
- Schooner, P., Nordlöf, C., Klasander, C., & Hallström, J. 2017. Design, System, Value: The Role of Problem-

Solving and Critical Thinking Capabilities in Technology Education, As Perceived By Teachers. *Design and Technology Education: An International Journal*. 22 (3), 1-16.

Universitas Negeri Surabaya. 30 Juni 2017, Surabaya, Indonesia.

Solikah, Ayu Ni'matus., dan Susantini, Endang. 2022. Pengembangan E-Book Interaktif Materi Pewarisan Sifat untuk Melatihkan Keterampilan Berpikir Kritis Peserta Didik Kelas XII SMA. *Bioedu*. 11(2): 374-383.

Suarsana, I. M. & Mahayukti, G.A. 2013. Pengembangan E-Modul Berorientasi Pemecahan Masalah untuk Meningkatkan Keterampilan Berpikir Kritis Mahasiswa. *Jurnal Pendidikan Indonesia*. 2 (2), 264-275.

Sujadmiko, H., & Vitara, P. E. 2021. *Tumbuhan Lumut di Kampus UGM*. UGM PRESS.

Sulistyaningsih, Yohana C. 2007 *Perkembangan Tumbuhan. In: Struktur dan Perkembangan Ganggang, Lumut, dan Tumbuhan Paku*. Universitas Terbuka, Jakarta, pp. 1-66. ISBN 9796897571.

Supriatna, E. (2020). Penerapan Model Pembelajaran *Problem Based Learning* (PBL) untuk Meningkatkan Hasil Belajar Siswa. *Journal of Classroom Action Research*, 2(1), 15-19.

Susantini, Endang et al. 2021. E-Book of Metacognitive Learning Strategies: Design and Implementation to Activate Student's Self-Regulation. *Research and Practice in Technology Enhanced Learning*. 16:13.

Syahrir. 2019. Penggunaan Pendekatan Pembelajaran Saintifik dalam Meningkatkan Hasil Belajar Matematika Siswa. *Jurnal Ilmiah Mandala Education*. 5 (2):108-113.

Syamsi, A. N. dan Fitrihidajati, H. 2021. Validitas Lembar Kegiatan Peserta Didik (LKPD) Berbasis *Problem Based Learning* (PBL) pada Materi Perubahan Lingkungan untuk Melatihkan Keterampilan Berpikir Kritis Siswa Kelas X SMA. *BioEdu*. 10 (2): 397-402.

Wijaya, E. Y., Sudjimat, D. A., & Nyoto, A. 2016. Transformasi Pendidikan Abad 21 sebagai Tuntutan Pengembangan Sumber Daya Manusia di Era Global. *Prosiding Seminar Nasional Pendidikan Matematika 2016-* Universitas Kanjuruhan Malang. 1, 263-278.

Wisanti, Indah, N. K., & Putri, E. K. 2016. *Taksonomi tumbuhan 1 Ruang Lingkup Taksonomi Bryophyta*. Unesa University Press.

Zubaidah, S. 2017. Berpikir Kritis: Kemampuan Berpikir Tingkat Tinggi yang dapat Dikembangkan melalui Pembelajaran Sains. *Seminar Nasional Sains 2010 dengan Tema "Optimalisasi Sains untuk Memberdayakan Manusia" At: Pascasarjana*