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Practicality and Effectiveness of E-Worksheet Based on ExPRession Learning Model Activities to Train Critical Thinking Skills

Hindun Eka Fenanda[1], Kartini Herlina[2*], Abdurrahman[3]

[1,2,3]Department of Physics Education, University of Lampung, Bandar Lampung – Indonesia

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CORRESPONDENCE AUTHOR

*E-mail:
kkartini.herlina@gmail.com

ABSTRACT.
Critical thinking skills are one of the essential abilities students must possess to face the developments in science and technology in 21st-century learning. The aim of this research is to describe the practicality and effectiveness of ExPRession-based e-worksheet activities in training critical thinking skills. The research design employed a pretest-posttest control group design. The research sample consisted of students from 12th-grade Science 1 and 3 at Public Senior High School Abung Semuli. Research instruments included observation sheets for lesson implementation, observation sheets for critical thinking activities, and critical thinking skills test sheets. Data on the practicality of learning were obtained through observations, while effectiveness data, in the form of critical thinking skills data, were obtained through pretest and posttest administration, and then analyzed using statistical formulas. Learning with ExPRession-based e-worksheets was deemed effective in training students' critical thinking abilities, as evidenced by the average N-Gain scores in the experimental group being higher than those in the control group. Based on these findings, critical thinking skills improved more significantly in the experimental group compared to the control group. Supported by the results of Independent Sample T-Test and Effect Size tests with a wide category, it can be concluded that ExPRession-based e-worksheet activities are effective in training students' critical thinking skills..

INTRODUCTION

Learning activities in the 21st century are oriented toward the rapid development of science and technology. Learners as future generations must master various learning skills such as creative and innovative thinking, critical thinking and problem-solving, communicating, and collaborating to compete globally (González-Pérez & Ramírez-Montoya, 2022). Critical thinking skills are one of the skills that students must have in dealing with the development of science and technology in 21st-century learning (Andriani et al., 2020). Critical thinking skills are related to connecting all knowledge or concepts possessed to make rational and reliable decisions (Miele & Wigfield, 2014). Critical thinking skills are essential aspects that students need because they are very useful in solving problems and as a provision in facing life today and in the future (Syukri et al., 2022). Educators as facilitators play an essential role in the learning process, one of which is by placing students as the center of learning so that students can be more active and accustomed to practicing their critical thinking skills. Practicing essential thinking skills makes students show performance in learning,

understand concepts well, become effective communicators, competent problem solvers, and become experts in the field they master (Zivkovic, 2016).

Critical thinking skills can be trained through learning about the phenomena of physics in everyday life. However, students have difficulties understanding physics concepts, such as applying knowledge in new situations and real life (Camarao & Nava, 2017). One of the materials that are considered difficult by students in physics learning is optics, especially in light interference material. Students have difficulty interpreting the pattern of double-slit or multi-slit light interference results and the tendency to be able to determine the ideas of optics in visualizing the effects of light interference that occurs (Mc. Dermot, 2000). Concept mastery affects students' critical thinking skills (Sa'adah et al., 2017). In addition to solving optical problems, students must be able to analyze solutions based on available information, and critical thinking plays an essential role in this (Octaviana et al., 2020).

There are several difficulties during learning activities, including limited practicum tools, limited learning resources that contain problem representations, and limited learning media (Fadilah, 2023). One of the 21st-century skills, namely critical thinking skills possessed by students, is still in the medium and low categories (Susilawati et al., 2020). Presenting teaching materials in the learning process can make it easier for students to learn material that has yet to be understood (Setyowati et al., 2018). A worksheet is one of the teaching materials that can make it easier for students to understand the material (Lee, 2014). Along with the development of science and technology, it is important to make updates in learning activities by replacing printed worksheets with electronic worksheets (Hidayati et al., 2021). Electronic worksheets are worksheets that contain a summary of the material, questions, and instructions for carrying out tasks in the form of text, audio, video, and animation that must be done by students and refer to the essential competencies that must be achieved so that they can help students learn in a directed, active, and critical manner (Awe & Ende, 2019). Actively engaging students in collaborative learning activities can encourage the development of critical thinking if the thinking process model instruction uses effective interrogation techniques and can guide students in the critical thinking process (Halmaida et al., 2020). The ExPRession learning model can be applied to physics learning on the topic of Optics (Light Interference) to stimulate students' system thinking and numeracy skills (Haryanti et al., 2023). In addition, implementing the ExPRession learning model in teaching materials, one of which is an e-worksheet, can build students' computational thinking skills (Pratiwi et al., 2023). Based on the problem description, this research aims to describe the practicality and effectiveness of e-worksheets based on ExPRession learning model activities to train students' critical thinking skills.

RESEARCH METHODS

Research Approach

The research that has been conducted uses a quasi-experimental method with a pretest-posttest control group design. In this design, the observed group is given a pretest-posttest before and after learning using the e-worksheet based on the ExPression learning model to review its effect on students' critical thinking skills.

Research Participants

The population in this research were all students of 12th-grade Science at Senior High School 1 Abung Semuli in the 2023/2024 academic year, consisting of 5 classes. The sample used in this study was 12th-grade Science 3 as an experimental class of 32 students and 12th-grade Science 1 as a control class of 32 students. This study uses a purposive sampling technique based on comparing the average learning outcomes of students in 12th-grade Science.

Research Instruments

The data collected are learning practicality data and effectiveness data in the form of data on students' critical thinking skills. The instruments used to collect data on the practicality of learning are the observation sheet for implementing learning using the ExPRession model and the observation sheet for the critical thinking skills activity. The instrument used to collect data on critical thinking skills is a test sheet in the form of essay questions, which are prepared following the indicators of critical

thinking skills. The instrument used went through validity and reliability tests, which were performed on 32 respondents. Based on the results of the validity test, $r_{count} > r_{table}$ so that the four questions are declared valid. The reliability test results obtained $r_{count} = 0{,}735 > r_{table} = 0{,}338$, so the questions can be used for pretest and posttest in research.

Data Collection

Learning practicality data is obtained through observations made during learning activities by applying e-worksheets based on ExPRession learning model activities. At the same time, the effectiveness data in critical thinking skills data is obtained through pretests conducted before learning activities and posttests after learning activities in experimental and control classes. The test given to students uses the same test questions. It aims to determine students' learning outcomes before and after learning activities.

Data Analysis

This research has two data analyses, namely practicality data analysis and effectiveness data analysis. Practicality data analysis describes observation data obtained by researchers using e-worksheets based on ExPRession learning model activities. The effectiveness of data analysis is to analyze the sample data obtained using statistical formulas and then draw conclusions.

1. Practicality Data Analysis

Analysis of practicality data in the form of observation data on the implementation of learning by applying the ExPRession learning model using percentage analysis as follows.

$$\text{Practicality} = \frac{\text{Number of aspects implemented}}{\text{Number of aspects observed}} \times 100\%$$

The percentage of learning practicability obtained can be converted to criteria, as found in Table 1.

Table 1. Criteria for percentage assessment of learning implementation

Percentage (%)	Category
0,00% - 20%	Very low
20,1% - 40%	Low
40,1% - 60%	Medium
60,1% - 80%	High
80,1% - 100%	Very high

Source: (Arikunto, 2013)

Analysis of critical thinking skills activity observation results using percentage analysis as follows.

$$\%\text{Score} = \frac{\text{Score obtained}}{\text{Maximum score}} \times 100\%$$

The percentage of critical thinking skills activity obtained can be interpreted as in Table 2.

Table 2. Criteria for percentage assessment of critical thinking skills activity

Percentage (%)	Category
80% - 100%	Very good
60% - 80%	Good
40% - 60%	Fair
20% - 40%	Deficient
< 20%	Very poor

Source: (Arikunto, 2013)

2. Effectiveness Data Analysis

a. Normality Test

The data normality test in this research was analyzed using the Kolmogorov-Smirnov Test on SPSS software. The basis for decision-making is if the Asymp. Sig. or significant > 0.05 means the data is normally distributed if the Asymp. Sig. or significant < 0.05 means the data is not normally distributed.

b. Homogeneity Test

A homogeneity test is conducted to determine whether the research sample is homogeneous. Homogeneous data is continued with parametric statistical hypothesis testing and inhomogeneous data is continued with non-parametric hypothesis testing. The basis for decision-making in this test is if the Sig. or significant value > 0.05 means that the data has a homogeneous variant, but if the Sig. or significant value < 0.05, it means that the data has an inhomogeneous variant.

c. N-Gain Test

The N-Gain test was conducted to determine the increase in student learning outcomes after being treated. This increase is based on students' pretest and posttest scores in the experimental and control classes. N-Gain can be calculated using the following equation.

$$\text{N} - \text{Gain} = \frac{\text{Posttest value} - \text{Pretest value}}{\text{Ideal minimum score} - \text{Pretest value}} \times 100\%$$

The criteria for interpreting the N-Gain value are in Table 3.

Table 3. N-gain interpretation criteria

N-Gain	Criteria
0,7 ≤ 1,0	High
0,3 ≤ 0,7	Medium
N-Gain < 0,3	Low

(Meltzer, 2002)

d. Independent Sample T-Test

The Independent Sample T-test is conducted to determine whether there is a significant average difference between the two sample groups. The hypothesis tested is as follows.

H_0 : There is no difference in the critical thinking skills of students between classes using e-worksheets based on ExPression learning model activities and those using conventional worksheets.

H_1 : There is difference in students' critical thinking skills between classes using e-worksheets based on ExPression learning model activities and those using conventional worksheets.

Decision-making is based on the significance level $\alpha = 0.05$. H_0 is rejected if Sig. < α; otherwise, H_0 is accepted if Sig. ≥ α.

e. Effect Size Test

Effect size is used to determine the effect of using an e-worksheet based on the ExPression learning model on students' critical thinking skills. Effect size can be calculated using the equation according to Cohen et al. (2007).

$$\text{d} = \frac{\overline{\text{X}}_1 - \overline{\text{X}}_2}{\text{S}_{\text{pooled}}}$$

The results of the calculation can be interpreted in Table 4.

Table 4. Interpretation of cohen's value

Cohen's Value	Category
0,00-0,199	Very low
0,20-0,399	Low
0,40-0,599	Medium
0,60-0,799	High
0,80-1,000	Very high

(Cohen et al., 2007)

RESULTS AND DISCUSSION

Results

Learning Practicality Results

The practicality of learning using the ExPRession learning model can be seen through the analysis of the observations of learning implementation and the results of observations of critical thinking skills activities that have been adjusted to the indicators of critical thinking skills. The results of the implementation of learning using the ExPRession learning model are presented in Figure 1.

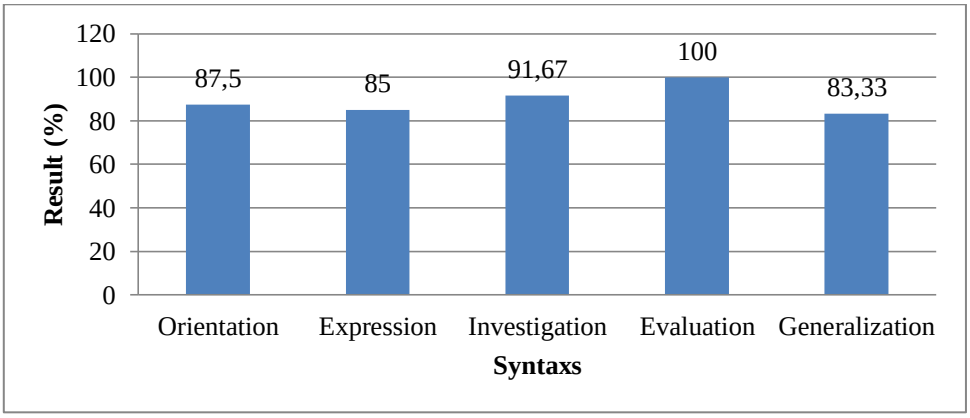

Figure 1. Analysis implementation of the exPRession learning model

The results of the analysis of student's critical thinking skills activities on each indicator are presented in Figure 2.

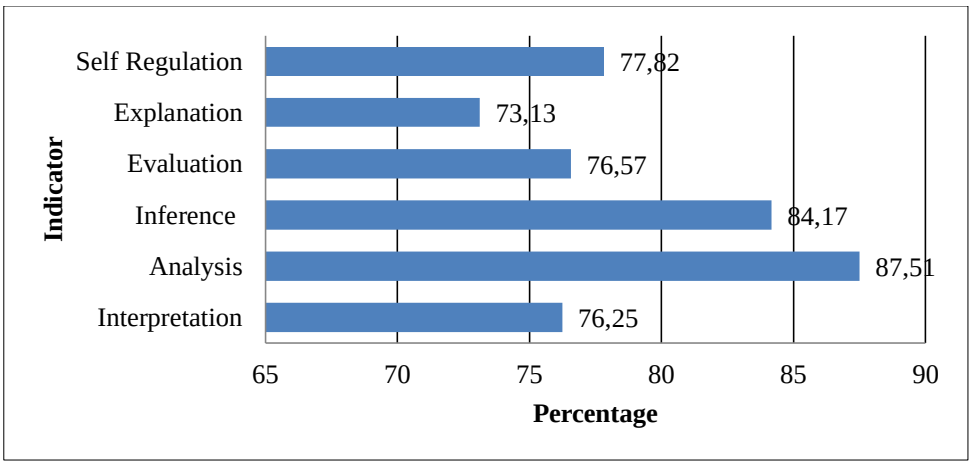

Figure 2. Analysis of critical thinking skills activities

Learning Effectiveness Results

1. Normality Test Result

The results of the normality test in the control and experimental classes are presented in Table 4.

Table 4. Normality test results

Class	Komogorov Smirnov			Category
	Statistic	df	Sig.	
Pretest Experiment	0,127	32	0,200	Normal
Posttest Experiment	0,114	32	0,200	Normal
Pretest Control	0,079	32	0,200	Normal
Posttest Control	0,109	32	0,200	Normal

Table 4 shows that the experimental and control classes have a significance value greater than 0.05. Based on the test hypothesis, if Sig. > 0.05, the data is normally distributed.

2. Homogeneity Test Result

The homogeneity test result of students' critical thinking skills can be seen in Table 5.

Table 5. Homogeneity Test Results

Levene Statictic	df1	df2	Sig.	Category
0,037	1	62	0,849	Homogen

The Sig value is known based on the Levene Statistic test results in Table 5. 0.849 > 0.05 so that the data on the results of critical thinking skills of experimental and control classes have the same variant or homogeneous.

3. N-Gain Test

The results of the N-Gain test for each class are presented in Table 6.

Table 6. N-gain test results for each class

Class	Score Acquisition			Category
	Highest N-gain	Lowest N-gain	Average N-gain	
Experiment	0,93	0,58	0,69	Medium
Control	0,62	0,29	0,45	Medium

The N-Gain test results for each indicator are presented in Table 7.

Table 7. N-gain test results for each indicator

Critical Thinking Skills Indicators	Experiment Class		Control Class	
	N-Gain	Category	N-Gain	Category
Interpretation	0,61	Medium	0,50	Medium
Analysis	0,83	High	0,47	Medium
Inference	0,71	High	0,51	Medium
Evaluation	0,70	Medium	0,40	Medium
Explanation	0,56	Medium	0,29	Low
Self Regulation	0,75	High	0,53	Medium

4. Independent Sample T-Test Result

The results of the independent sample T-test can be seen in Table 8.

Table 8. Independent sample t-test test results

Class	N	Mean	SD	T	Sig. (2-tailed)
Experiment	32	79,30	7,75	8,934	0,000
Control	32	62,34	7,33		

The Independent Sample T-Test test results in Table 8 show the sig value. (2 -tailed) 0,000 < 0,05 means a significant difference in the average critical thinking skills after treatment using an e-worksheet based on ExPRession learning model activities.

5. Effect Size Test

The results of the Effect Size test are presented in Table 9.

Table 9. Effect size test results

Class	Mean	S.D	Cohen's d	Interpretation
Experiment	79,30	7,72	2,234	Very High
Control	62,34	7,47		

Based on Table 9, the magnitude of the effect size value using Cohen's d is 2.234 with a very high category, meaning that the e-worksheet based on ExPRession learning model activities is very influential in training students' critical thinking skills.

Discussions

Discussion of Learning Practicality

1. Discussion of Implementation ExPression Learning Model

During the learning process, an e-worksheet based on ExPRession learning model activities was used to observe the implementation of learning. Then, the results of these observations were analyzed using percentage analysis. The analysis showed that the results of learning implementation in the evaluation syntax obtained the highest percentage of 100%. In this syntax, the researcher guides students to conduct class discussions related to problem-solving activities, which have been carried out as a form of self-reflection on their learning experience. Learners can learn content knowledge, acquire professional skills, and perform deeper cognitive and metacognitive processes. This is in line with Ismayanti et al. (2020), who revealed that reflection activities in learning can be used to improve critical thinking skills.

The analysis results on the generalization syntax obtained the lowest percentage of 83.33%. The activities carried out at this stage are to provide feedback on students' findings, direct students to make a resume by involving additional representations, and provide practice questions related to the topics discussed. Evans & Ellis (2017) state that educators must appropriately provide feedback on student's work so that students feel comfortable even though they are less understanding. Providing practice questions at the end of learning is done as a rehearsal activity so that the information obtained can last long in long-term memory. The average results of learning implementation of the five syntaxes observed by observers obtained a percentage of 89.50% in the very high category. Based on this data, it can be seen that the ExPRession learning model can be used as a reference for learning models in the classroom. This model's syntax is dominated by activities that train students to create various representations as an implication of building mental model structures (Herlina, 2020).

2. Discussion of Critical Thinking Skills Activities

During the learning process using e-worksheet based on ExPRession learning model activities, observations were made of students' critical thinking skills activities, which were then analyzed using percentage analysis. The analysis results presented that the activity of students' critical thinking skills in the analysis indicator dominated all learning activities, namely with a percentage of 87.51%. The analysis indicator is in the syntax of orientation, ExPRession, and investigation in the ExPRession learning model. In the orientation and ExPRession syntax, the analysis indicator learner activity identifies and connects a statement, question, and description through the displayed phenomenon, then formulate the problem according to the predictions made. Furthermore, in the investigation syntax, the activity of students in the analysis indicator is to analyze the variables related to the problems that have been found. Selviana et al. (2016) revealed that conducting an in-depth problem analysis shows that someone has good critical thinking skills.

The analysis results show that the activity of students' critical thinking skills on the explanation indicator obtained the lowest percentage, namely 73.13%. Activities carried out by students provide explanations related to the results of experiments by relevant procedures and concepts. In processing experimental data, students can connect the results of investigations or experiments with relevant concepts. However, students need help writing or communicating scientific explanations of the experiment's results. Sulistina (2021) revealed that scientific explanation skills require good cognitive abilities and communication skills. Lange (2011) stated that peer review can motivate students to improve their writing quality and learn how to write better scientific explanations. Based on this data, the average value of students' critical thinking skills activities is 80.16%, with the criteria for the percentage of students' critical thinking skills activities in the excellent category, meaning that in general, the activity of students' critical thinking skills in learning physics with the ExPRession model has been as expected.

Discussion of Learning Effectiveness

The results presented that the e-worksheet based on ExPRession learning model activities effectively improved students' critical thinking skills (effect size Cohen's D = 2.234). The increase in students' critical thinking skills between experimental and control classes can be seen through the pretest and posttest N-Gain test results. Students' critical thinking skills by applying e-worksheets based on ExPression learning model activities in the experimental class increased more with the average N-Gain value of 0.69, included in the moderate category. In the control class, students' critical thinking skills were in the moderate category, with an average N-Gain of 0.45. Based on this, students' critical thinking skills in the experimental class increased more than in the control class. The hypothesis test results using the Independent Sample T-Test obtained a Sig. A value of 0.000 means there are differences in students' critical thinking skills in experimental and control classes. The test instrument used to see the effectiveness of using an e-worksheet based on the ExPRession learning model activities amounted to four questions, each referring to the six indicators of critical thinking skills.

The results of the N-Gain analysis for the interpretation indicator showed an increase in critical thinking skills in the experimental and control classes. Applying an e-worksheet based on the ExPression learning model activities in the experimental class proved to train the interpretation indicator 0.61 with a moderate category. In this interpretation indicator, students can understand and ExPRess the meaning or intent of various representations such as statements, images, tables, and graphs. Supported by Herlina (2020), the ExPRession learning model emphasizes training students to make various representations to impact students' ability to solve problems related to the given concept. In the analysis indicator, the experimental class, by applying an e-worksheet based on the ExPRession learning model activities, obtained an N-Gain value of 0.83 with a high category. The control class obtained an N-Gain value of 0.47 with a medium category. This indicator ranks highest compared to other indicators. Students are highly trained in analyzing or identifying a variable or statement in this indicator. Selviana et al. (2016) revealed that conducting an in-depth problem analysis shows that someone has good critical thinking skills.

In the inference indicator, the experimental class, by applying an e-worksheet based on the ExPRession learning model activity, obtained an N-Gain value of 0.71 with a high category. The control class obtained an N-Gain value of 0.51 with a medium category. In this indicator, students can identify and determine aspects and consider the information obtained to make conclusions. Supported by Halpern (2014), learners must be able to identify information and apply it to find answers to given questions, solve problems, or reach reasonable conclusions. In the evaluation indicator, by applying an e-worksheet based on ExPRession learning model activities, the experimental class obtained a more excellent N-Gain value of 0.70 with a medium category than the control class, which was 0.51 with a medium category. In this indicator, students can use appropriate and complete strategies in performing calculations to solve problems. Supported by Indira et al. (2017), namely solving problems using the right, complete, and correct strategy can improve students' evaluation skills.

In the explanation indicator, by applying an e-worksheet based on ExPRession learning model activities, the experimental class obtained a more excellent N-Gain value of 0.56 with a medium category than the control class, which amounted to 0.29 with a low category. The explanation indicator is in the lowest order compared to other indicators. The low explanation indicator is due to students who need help to provide logical or reasonable explanations or reasons for a question given in the problem. Supported by Hayudiyani et al. (2017), the low explanation indicator is caused by students who need help to write the final results and explain and provide reasons for the conclusions drawn logically and reasonably, which greatly affects students' critical thinking skills.In the self-regulation indicator, by applying an e-worksheet based on ExPRession learning model activities, the experimental class obtained a greater N-Gain value of 0.75 with a high category than the control class, which was 0.59 with a medium category. In this indicator, students can provide a review of the answers that have been written previously.

Based on the study's results, it was found that applying e-worksheets based on ExPRession learning model activities is better for practicing students' critical thinking skills because real learning focuses more on students solving problems with the help of various learning resources that can support their findings, so it has an impact on the training of students' critical thinking skills. In addition, the ExPRession learning model requires students to be able to solve problems using various representations so that students understand physics concepts better.

CONCLUSION

The practicality of using e-worksheets based on ExPRession learning model activities effectively trains students' critical thinking skills. The results of the practicality test using the learning implementation observation sheet using the ExPRession learning model in the experimental class reached 89.50% in the very well-implemented category, and the assessment of students' critical thinking skills activities reached a value of 80.16% in the excellent category. The e-worksheet based on ExPRession learning model activities effectively trains students' critical thinking skills. The results of hypothesis testing show a difference in students' critical thinking skills in the experimental class using e-worksheets based on ExPRession learning model activities, which are higher than in the control class using conventional worksheets. School teachers are expected to apply e-worksheets based on ExPRession learning model activities in the physics learning process to achieve physics learning objectives. In addition, other researchers are expected to conduct further research on the ExPRession learning model both in the field of physics and in different fields of study to obtain more accurate results to improve the quality of education in general. The weakness of this study is that when researchers carry out the assessment process manually, it would be better if the assessment is carried out digitally because it makes it easier to carry out the assessment process.

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