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The Development of an Environment-Based Guided Inquiry Learning Model accompanied by Event Chain to Improve Students' Critical Thinking Skills

Emy Shofiah Setyowati[1]*, Sri Yamtinah[2], Prabang Setyono[3]

[1]*Department of Science Education, Sebelas Maret University Surakarta*
[2]*Chemistry Education, Sebelas Maret University Surakarta*
[3]*Environmental Science, Sebelas Maret University Surakarta*

Corresponding E-mail: [1]emyshofiahs@student.uns.ac.id, [2]jengtina@staff.uns.ac.id, [3]prabangsetyono@staff.uns.ac.id

Abstract: This study aims to determine the validity, feasibility, and effectiveness of an environment-based guided inquiry learning model accompanied by an Event Chain in improving students' critical thinking skills in Science learning on environmental pollution material. The contribution of this research to knowledge is to provide new innovations in Learning Approaches by developing new learning models that aim to improve students' critical thinking skills. This research is a type of Research and Development that refers to the ADDIE development procedure which encompasses stages including analysis, design, development, implementation, and evaluation. The research subjects were seventh grade students of SMP N 3 Kartasura. This study use instruments in the form of validation sheets, student critical thinking skills tests, and learning modules. Data analysis techniques in the study consisted of validity test, feasibility test, and effectiveness test. The results showed that the learning model developed based on the assessment of seven validators was declared valid and ready to be tested with some improvements in input from the validator. The feasibility test results were feasible with a sig value of 0.00 <0.05, so the developed model had an effect in improving critical thinking skills. The effectiveness test using the N-Gain Score in percent form was 76.33% and it was within the effective category.

Keywords: Guided Inquiry Learning Model, Environment-Based Learning, Event Chain, Critical Thinking Skills

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1. Introduction

Entering 21st century education, students are required to have the ability to solve problems and challenges in their era to prepare themselves for the future or the challenges of century development. The abilities or skills that students must have in 21st century education are learning and innovation skills, specifically critical thinking, creativity, collaboration, and communication which are then abbreviated as 4C (Sari & Trisnawati in Manahal, 2009). One of the important competencies in preparing students to face future challenges is the ability to think critically.

Critical thinking is also one of the aspects that exist in Pancasila students. It is stated in Permendikbud Number 22 of 2020 that Pancasila students have six main characteristics, namely 1) faith, devotion to God Almighty, and noble character, 2) global diversity, 3) mutual cooperation, 4) independence, 5) critical reasoning, and 6) creativity. According to Permendikbud Number 22 of 2020, students who reason critically are able to objectively process both qualitative and quantitative information, build links between various information, analyze information, evaluate, and conclude. Critical thinking skills are fundamental skills for learning in the 21st century. According to Kadir (2016) critical thinking has been positioned as one of the core foundations of educational reform accompanied by a push for student-centered pedagogy in addressing global challenges around the world. Critical thinking is essential to improve students' cognitive abilities while effectively retaining information, a skill acquired through the learning process (Herzon, Budianto & Utomo., 2018).

Ennis (1989) defines critical thinking as wise thinking that is logical and focuses on determining what should be done or believed. The aspects of critical thinking skills that are used to measure the level of critical thinking skills based on the Facione (2015) findings are interpretation, analysis, evaluation, inference, explanation, and self-regulation.

The implementation of 21st century education has not been maximized because there are problems in its implementation (Sofwan & Habibi, 2016). These problems include power relations, professionalism and quality of human resources, and curriculum issues. The implementation of 21st century education has not maximized students' critical thinking skills. The results of the study indicated that students' critical thinking skills scored 40.46, which fell into the low category, and thus still needed to be trained further so that they could be improved (Nuryanti, Zubaidah and Diantoro, 2018). Myers and Dyer (2006) also analyzed students' critical thinking skills and the results of the study stated that the students' critical thinking skills score remained low, at 27.87 out of a maximum score of 40.

The low critical thinking skills of students are due to the fact that teachers still dominate in the learning process, in other words, the approach still uses teacher-centered learning. In addition, student activities in learning tend to focus on memorizing material rather than developing thinking capability (Verina, 2010; Graciella, 2016). Whereas, teaching students to think critically is one of the main goals of education (Kazempour, 2013; Kaleiloglu & Gulbahar, 2014; Zubaidah, 2010).

The learning model used has not empowered students' critical thinking skills. Therefore, a learning model is needed that is in accordance with the nature of Science and invites students to conduct investigations or experiments in forming Science concepts. One of the learning models that emphasizes process skills, thinking skills, and scientific inquiry is the guided inquiry learning model. The guided inquiry model is a learning model that helps students to learn and gain knowledge by discovering for themselves what is being learned, including the discovery of meaning, organization, and structure of ideas or ideas, so that gradually students learn how to organize and conduct research. In organizing the concepts that have been obtained, it will be more organized if assisted by the concept map of the flow of events (Event Chain). Event Chain concept maps can be used to provide a sequence of events, steps in a procedure, or stages in a process (Hardianti, 2014).

The independent curriculum is a curriculum that was once referred to as a prototype curriculum which was later developed as a more flexible curriculum framework, while focusing on essential material, character development, and student competencies. The habitat of living things on this earth is the environment, therefore material related to the environment is an essential material that students need to master in learning. One of the materials related to the environment is environmental pollution.

Science learning, especially regarding environmental pollution, is more appropriate if conducted using environment-based learning. Employing environment-based learning can also improve students' critical thinking skills. This statement is further supported by a research conducted by Mu'minah in 2018 which states that employing environment-based learning can significantly improve students' critical thinking skills. This is evidenced by the data on the average score of students prior to learning, which is 67.91, smaller compared to the average score of 81.57 after learning. Utilizing the environment as a learning resources can facilitate students to absorb learning materials, get to know the actual environmental conditions, apply the knowledge gained, and participate in protecting and maintaining their environment.

The existing learning model has not empowered critical thinking skills so it is necessary to develop a learning model that can empower and improve students' critical thinking skills.

2. Method

This research is a type of development research that aims to create a particular product. Research and Development is a research method used to validate and develop products (Yuliani and Nurmauli in Sugiyono, 2019). The development method used is the ADDIE development method. The flowchart of the ADDIE method in this study is presented in Figure 1.

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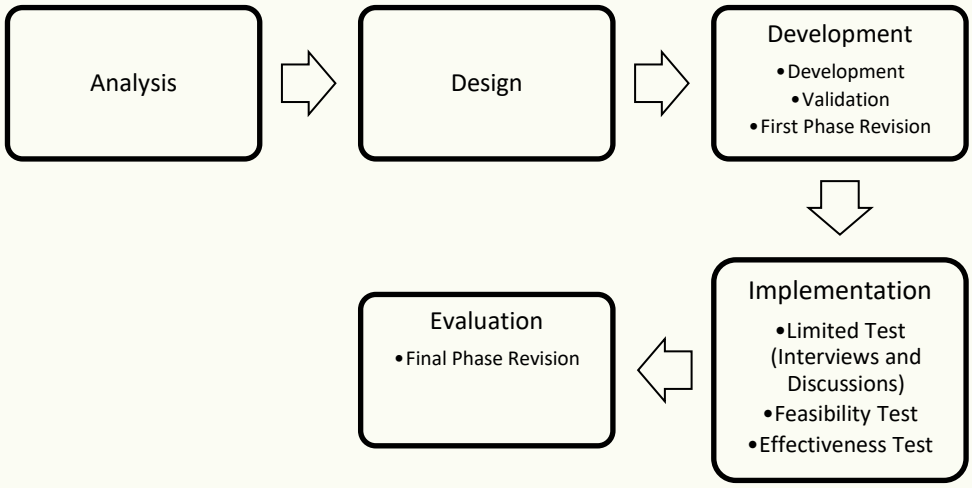

Figure 1. Flowchart of ADDIE

From the chart, the sequence of steps of the ADDIE method is analysis, design, development, implementation and evaluation. According to a research conducted by Juanda and Hendriyani in 2022, the design stages in the ADDIE method are analysis, design, development, implementation, and evaluation.

This research was conducted at SMP Negeri 3 Kartasura in the academic year 2023/2024 in the even semester. The research subjects were all seventh grade students, specifically, 5 students were chosen for limited test with interview technique, 31 students for feasibility test with test technique, and 62 students for effectiveness test with test technique. Data collection techniques in this study were validation sheets, interviews, and tests. Data analysis techniques used in this study are Aiken validity, homogeneity test, normality test, ANOVA test, and effectiveness test.

3. Result and Discussion

This research was conducted at SMP Negeri 3 Kartasura with seventh grade students serving as the sample. The results of the development of this learning model are teaching modules with an environment-based guided inquiry learning model accompanied by Event Chain to improve the critical thinking skills of seventh grade students on Environmental Pollution material. The results of the literature study concluded that students' thinking skills were still in the low category. One of them is a research conducted by Myers and Dyer (2006), they analyzed students' critical thinking skills, and the results of the study stated that the score of students' critical thinking skills were still low at 27.87 from a maximum score of 40. Therefore, researchers conducted interviews and observations in the field. During the learning process, there were not many questions asked by students. This shows that students' critical thinking skills are low. To support the results of interviews and

observations, a test of students' initial critical thinking skills was conducted. The results of the students' initial critical thinking skills test are as follows:

Table 1. Critical Thinking Skills Pretest

Score/Percentage	Criteria	Frequency
81 - 100	Very High	0
61 - 80	High	1
41 - 60	Medium	16
21 - 40	Low	12
0 - 20	Very Low	2
sum		31

Based on Table 1, there is only 1 student out of 31 students who is in the high category, the rest are in the medium, low, and some are even in the very low category. In addition to the findings of the low critical thinking skills of students, another finding obtained from observation and interview activities revealed that the learning methods often employed by teachers in the learning process is the lecture and demonstration method.

Based on the results from the analysis stage, the design stage involves creating a learning model that is suitable for improving students' critical thinking skills. The model is an environment-based guided inquiry learning model accompanied by an Event Chain. At this stage, the product design involves determining indicators of critical thinking skills, determining the material to be studied, determining learning objectives, determining the format, and visualization of teaching modules.

At the development stage, the initial product prototype was prepared. Early stage module development was guided by the determination of learning objectives, materials, learning models developed, format, and visualization of teaching module content. The initial design of the developed teaching module has the following components: front page, teaching module identity sheet, core competency sheet containing learning outcomes, assessment and learning activities, signature section, and attachments.

This learning model was developed since there is currently no learning model to support the improvement of students' critical thinking skills. The results of the development are teaching modules oriented towards the environment-based guided inquiry learning model, accompanied by an Event Chain. The purpose of developing this module is to improve critical thinking skills through discoveries made via experiments and group discussions about environmental problems. Through the activities in the developed teaching module, critical thinking skills are also practiced. The integration of critical thinking aspects in the developed learning model is as follows:

Table 2. Learning Model Syntax

No	Guided Inquiry Syntax	Scientific Approach	Critical Thinking Aspects
1	Orientation	Observe	- Interpretation
2	Formulate Problems and Hypothesize	Questioning	- Analysis - Explanation - Self-Regulation

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			- Evaluation
3	Collecting Data	Exploring	- Analysis
4	Testing Hypotheses / Reasoning	Reasoning	- Analysis
5	Formulating Conclusions		- Inference
6	Communicating	Communicating	- Explanation - Interpretation - Analysis - Inference - Evaluation - Explanation - Self-Regulation

After the initial module is finished, the validity of the teaching module is carried out to learning practitioners, material experts and learning experts. Teaching module validation is a process of activities to test the suitability of teaching modules with competencies that become learning objectives. The teaching module developed aims to improve student competence, namely students' critical thinking skills.

The results of Aiken validation of teaching modules from indicator 1 to indicator 24 exceed the value of Vtabel, indicating their validity. However, the Aiken validation value of indicator number 21 (0.619048) is below 0.76, rendering it not valid. This is because when the initial product was developed, there was no bibliography. After going through the validation process, the teaching module, the assessment instrument, and observation instrument are ready for field testing with some improvements according to the suggestions and validation results.

After the development stage, the next stage is the implementation stage. The first implementation was a limited test using a discussion about the teaching module implemented in learning. The limited test was conducted on 5 seventh grade students of SMP Negeri 3 Kartasura using the discussion method. The result of the discussion was that the existence of an environment-based guided inquiry learning model accompanied by Event Chain could support the improvement of students' critical thinking skills. With environment-based learning during assignments, students feel they have to think hard to find environmental problems and also make narratives based on these problems. With these assignments students' critical thinking skills will be trained through finding problems in the surrounding environment. Apart from identifying problems, critical thinking skills can also be trained through learning as students are required to answer questions, analyze related environmental issues based on videos and experiments, and create concept maps of the events flow after learning. Learning activities are somewhat constrained because students are not used to doing critical thinking. Thus, making narratives and answering questions related to environmental problems takes a bit longer. In addition, regarding the type of media used, students are more interested in conducting experiments than just watching problem-related videos. Following this, the feasibility test was conducted.

The feasibility test was conducted at SMP Negeri 3 Kartasura with the research subjects being 31 students from class VII D. Before the implementation of the

developed learning model, students took a pretest of critical thinking skills. After the learning was completed, students took the posttest, the results were presented in table 3.

Table 3. Average Pretest and Posttest Scores of Feasibility Test

	Test	Average
Critical Thinking	Pretest	40.90
	Posttest	86.74
	Total	63.82

Based on the descriptive analysis that has been carried out with the help of the SPSS program, it can be seen that the average critical thinking pretest score is 40.90 and the posttest score is 86.74.

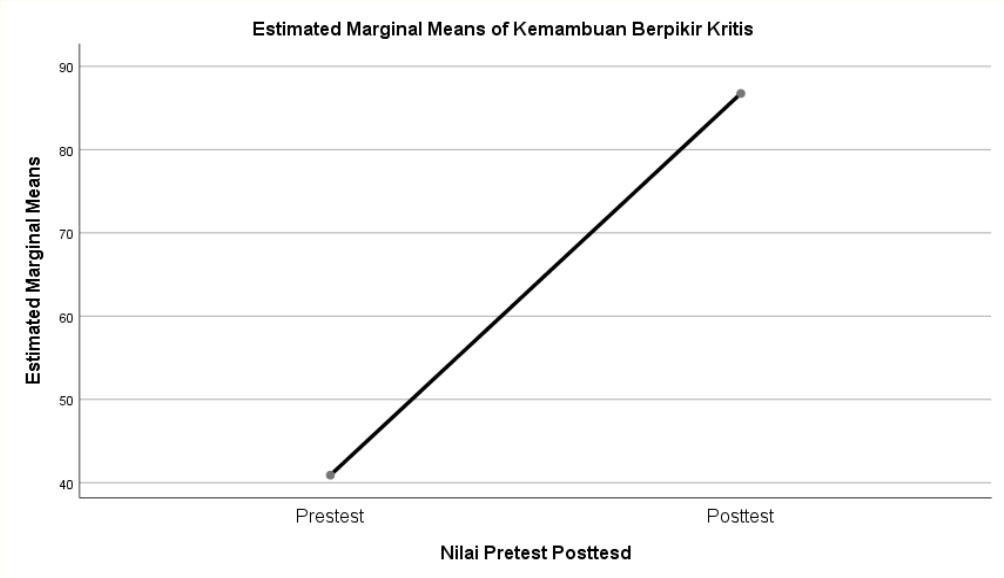

Figure 2. Graphics Pretest-Posttest

Based on Figure 2, the results of the SPSS program clearly show an increase in the average pretest and posttest scores for critical thinking skills. In the data, the feasibility test is carried out using the ANOVA test. Before testing the feasibility of the ANOVA test, the data is required to be normally distributed. Based on the results of the test of normality, it can be seen that the pretest sig value of critical thinking ability is 0.407>0.05, so the critical thinking ability pretest data is normally distributed. The average posttest score has a sig value of 0.468>0.05, so the average posttest score of critical thinking skills is normally distributed. Based on the results of the test of homogeneity of variances, the average value of critical thinking ability has a sig value of 0.002 <0.05, so the data is considered homogeneous or not uniform. So, ANOVA test was conducted on both variables to determine the significance of the difference in the average pretest and posttest scores after using the environment-based guided inquiry learning model accompanied by an Event Chain. The following are the results of the ANOVA test on the critical thinking ability variable with the help of the SPSS program with the results in the following table 4.

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Table 4. ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	32568.403	1	32568.403	1147.687	.000
Within Groups	1702.645	60	28.377		
Total	34271.048	61			

The ANOVA test results show that the critical thinking sample data has a sig value of 0.00 <0.05, so Ho is rejected and Hi is accepted. This suggests that there is a difference in the average pretest and posttest scores of critical thinking skills. Based on the results of this analysis, the environment-based guided inquiry learning model accompanied by Event Chain has an effect in improving students' critical thinking skills, and this model deserves to be tested on a wider scale to test its effectiveness.

In the effectiveness test, the samples used were class VII G as the experimental class and class VII A as the control class. Subsequently, the experimental class was exposed to the Environment-Based Guided Inquiry Learning Model accompanied by Event Chain, while the control class was exposed to the Conventional Learning Model in order to gather data. This data was obtained using a posttest instrument. Pretest data was tested for homogeneity to determine that the data came from a homogeneous population. The sig value shows 0.684> 0.05 so the pretest data of the experimental class and control class are homogeneous. Therefore, the pretest-posttest data was tested for normality, since the requirement for the effectiveness test is that the data is normally distributed. The normality test in this study uses the Shapiro-Wilk normality test.

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Pre Test	Eksperimen	.125	31	.200*	.948	31	.138
	Kontrol	.101	31	.200*	.978	31	.748
Post Test	Eksperimen	.129	31	.200*	.946	31	.124
	Kontrol	.117	31	.200*	.954	31	.204

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 3 Test of Normality

Based on this Figure 3, the significance of the pretest of the experimental class is greater than 0.05, namely 0.138> 0.05, indicates the pretest data is normally distributed. Similarly, the significance of the pretest of the control class is greater than 0.05, namely 0.748> 0.05, also suggest that the pretest data is normally distributed. On the other hand, the significance of the posttest of the experimental class is greater than 0.05, namely 0.124> 0.05, indicates the class posttest data is normally distributed. Similarly, the significance of the posttest of the control class is greater than 0.05, namely 0.204> 0.05, which also indicates the class posttest data

is normally distributed. The N-Gain (normalized gain) Score test was conducted to determine the effectiveness of using the guided inquiry model based on accompanied Event Chain to improve students' critical thinking skills. N-Gain score can be calculated using the formula:

$$N - Gain = \frac{(Posttest\ Score - Pretest\ Score)}{(Ideal\ Score - Pretest\ Score)}$$

Description: Ideal score is the maximum value that can be obtained.

The categorization of the acquisition of N-Gain scores in the form of percentages can refer to the following categorization:

Table 5. N-Gain Effectiveness Interpretation Categories

Percentage (%)	Interpretation
<40	Not Effective
41-55	Less Effective
56-75	Moderately Effective
>76	Effective

Source: Hake, R.R., 1999

The following are the results of the N-Gain Score analysis in percent using SPSS 25 for critical thinking skills:

Descriptives

	Kelas			Statistic	Std. Error
NGain_Persen	Eksperimen	Mean		76.3273	1.87412
		95% Confidence Interval for Mean	Lower Bound	72.4888	
			Upper Bound	80.1547	
		5% Trimmed Mean		76.4840	
		Median		76.6667	
		Variance		108.882	
		Std. Deviation		10.43464	
		Minimum		55.22	
		Maximum		95.56	
		Range		40.33	
		Interquartile Range		14.21	
		Skewness		-.399	.421
		Kurtosis		-.126	.821
	Kontrol	Mean		34.4573	3.01818
		95% Confidence Interval for Mean	Lower Bound	28.2934	
			Upper Bound	40.6212	
		5% Trimmed Mean		35.1656	
		Median		38.5714	
		Variance		282.391	
		Std. Deviation		16.80450	
		Minimum		-7.02	
		Maximum		59.62	
		Range		66.63	
		Interquartile Range		16.84	
		Skewness		-.705	.421
		Kurtosis		.052	.821

Figure 4. Data of N-Gain Value of Critical Thinking Ability

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Based on the results of the N-Gain score calculation above, it shows that the average N-Gain score for the experimental class is 76.33%, indicating it falls within the effective category. While the average N-Gain score for the control class was 34.46%, indicating it falls within the ineffective category. The average results of critical thinking skills are presented in the following table.

Table 6. Average Pretest and Posttest Critical Thinking Ability

Class	Average Critical Thinking Pretest Score	Average Critical Thinking Posttest Score	N-Gain (%)	Categories
Control	37	58	34.46	Not Effective
Experiment	41	86	76.33	Effective

Based on Table 6, the average pretest value of critical thinking skills in the control class is 37 and after learning it has increased in the average posttest value of critical thinking skills to 58. The average pretest value of the experimental class is 41 and has increased in the posttest value of critical thinking skills to 86. The distribution of each criterion in the experimental class is in the following table.

Table 7. Distribution of Mean Critical Thinking Ability Score

Percentage	Criteria	Pre	Post
81 - 100	Very High	0	28
61 - 80	High	1	3
41 - 60	Fair	16	0
21 - 40	Less	12	0
0 - 20	Very Less	2	0
Total		31	31

Table 7 indicates that the posttest results in the experimental class are in the very high category for 28 students and in the high category for 3 students.

4. Conclusion

Based on the results of the analysis that has been carried out, the development of an environment-based guided inquiry learning model accompanied by Event Chains is declared valid with an average validity value of 0.806879 to improve students' critical thinking skills. There is an influence of the environment-based guided inquiry learning model accompanied by Event Chain with a sig value of 0.00 <0.05 to improve students' critical thinking skills, and was found effective to improve students' critical thinking skills with an N-Gain score of 76.33%.

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SHORT PROFILE

Emy Shofiah Setyowati, was born in Sukoharjo, April 20, 1998. Graduated with a Bachelor of Education (S.Pd) degree from Sebelas Maret University Surakarta in 2021. The author is an active student of Master of Science Education at Sebelas Maret University and also a teacher at SMP Negeri 3 Kartasura as a Science Subject Teacher since 2023. The author can be contacted via email: emyshofiahs@student.uns.ac.id.

Sri Yamtinah, was born in Surakarta, December 4, 1969. She received her Bachelor of Education (S.Pd) degree from Sebelas Maret University in 1993, Master of Education (M.Pd) degree from Yogyakarta State University in 1999 and Doctoral degree from Yogyakarta State University in 2014. Currently the author is listed as a lecturer in the Science Education and Chemistry Education Study Program at Sebelas Maret University.

Prabang Setyono, was born in Sleman in 1972. He received his Bachelor of Science (S.Si) degree from Gadjah Mada University in 1997, his Master of Science (M.Si) degree from Gadjah Mada University in 1999 and his Doctorate from Gadjah Mada University in 2006. The author obtained the title of Professor in 2022 and is valid starting January 1, 2022. Currently, the author is listed as a lecturer at the Environmental Science Study Program at Sebelas Maret

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