



Analysis of Guided Inquiry-Based Cladistic E-Worksheet Development to Improve Critical Thinking in High School

Purnamaulida Pratiwi¹, Topik Hidayat^{2*}, Amprasto³

¹Master Program of Biology Education, ^{2*,3}Departement of Biology Education, Universitas Pendidikan Indonesia

*Corresponding Author. Email: topikhidayat@upi.edu

Abstract: This research aims to analyze the development of Guided inquiry-based cladistic worksheet websites in high schools through that website that has already been developed. The research subjects were 36 students of class X at one of the high schools in Bandung. The research was used by using the experimental method. Students were given Guided inquiry-based cladistic worksheet websites. The instrument used was a Guided inquiry-based cladistic worksheet website, a Feasibility Test by expert lecturers, and a critical thinking test. Critical thinking skill use indicators are Simple Explanation, Conclude, Strategy and Tactics, Building basic skills, Make further explanations. The data were analyzed by using the paired sample T-test. The results showed that the cladistic worksheets based on guided inquiry were valid and effective (N-Gain= 0.54). The assessment analysis by the expert judgment was found to be feasible to be tested in the field without revision, besides that Guided inquiry-based cladistic e-worksheets after validation tests by expert lecturers were obtained from various aspects, such as the application of Guided inquiry to 100% cladistic e-worksheets, practical analysis obtained 91.6%, competency aspect analysis of 91.6%, knowledge construction, obtained a value of 80 and conformity or relevance to KD 100%. It can be concluded that the development of this media can improve students' critical thinking skills.

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Introduction

Globalization has broadly impacted all aspects of life, including the need for education. One of the real challenges is that education must develop human resources with complete competencies; these competencies are the main competencies that students must have to participate in real life in the 21st Century. This competency is the main competency that students must possess to participate in real life in the 21st Century. The challenge in this Century is to be able to create education to train thinkers who can participate in the development of knowledge-conscious social and economic order to adapt to the citizens of the world of the 21st (Wijaya et al., 2016). 21st-century learning, according to the *Partnership for 21st Century* (2015) develops a framework that requires students to have various skills, knowledge, use of technology, media and innovation, learning skills, and life skills. In addition, the Ministry of Education and Culture formulated the current learning paradigm emphasizing the ability of students to find problems from various sources, ask questions, think analytically, and collaborate and solve problems collaboratively (Kemendikbud, 2015). One of the supporting skills is critical thinking skills.

Critical thinking is an ability or way of thinking that contains questions, experiments, and belief in the knowledge that has been obtained through an experiment (Munandar &



Sutrio, 2018). According to Ennis, critical thinking is a reflective ability that focuses on deciding what to believe, do and be accountable (Susilawati et al., 2020). Research conducted by Changwong et al., (2018) suggests that students with high critical thinking skills will perform better academically in the school environment and better prepared for college. This skill is needed because someone who can think critically can think logically, answer problems well, and make rational decisions (Susilawati et al., 2020). Critical thinking involves an ongoing process of resolving and raising doubts (Southworth, 2022). Critical thinking can be trained with learning that can require students to carry out experimental activities, discovery, and problem-solving through discussion in groups (Aini et al., 2018). Students' critical thinking skills can be developed through the inquiry process. According to Gilles in Rositawati learning with the inquiry method can train students to think critically to deepen their knowledge of science, which can train them in higher-order thinking (Rositawati, 2019).

One of the inquiries learning models is guided inquiry. The learning model in guided inquiry is a model used in the process of finding and finding solutions to a problem, Besides that, the teacher only acts as a facilitator (Oktari et al., 2015). The results from Rands et al., (2021) showed that students who used guided inquiry had improved results in active knowledge skills when compared to the regular learning group. This model can direct students to acquire independent concepts and make students play an active role in learning activities. Research conducted developing guided inquiry-based learning can make students find answers to scientific problems and improve their critical thinking skills. Students are directed to find answers to a problem developed by the teacher (Ardi et al., 2015). The teacher asks students questions to solve, then guides students to find the best way to solve the problem (Anam, 2016). From the results of field observations, the researcher found a Guided inquiry activity in one of the schools during the Covid-19 period of learning. However, the implementation of learning activities still has drawbacks.

On the other hand, the high spread of Covid-19 has disrupted all aspects of life. One of them is in the field of education. The Covid-19 pandemic has impacted the world of education due to the imposition of social restrictions. Amid the increasingly worrying spread of Covid-19, Nadiem Makarim as Minister of Education and Culture, strongly supports the policy of face-to-face learning carried out online or working from home (Yustina et al., 2020). Constraints in the implementation of online learning are caused by students' difficulty adapting and teachers who are not ready to suddenly carry out learning activities (Fauzy & Nurfauziah, 2021). The study result show that teachers have not been able to provide digital learning tools, and the learning process that has taken place has not been systematic because of the unavailability of teaching materials so that the increase in students' abilities related to learning is minimal (Permana P & Manurung, 2020). Therefore, using and utilizing information and communication technology in learning can support and develop cognitive, affective, and social skills (Ganefri et al., 2017).

One solution or answer to the given problem is to use e-worksheets. E-worksheet is one solution for enriching the mastery of the material students (Choo et al., 2011). E-worksheets are also a means to facilitate learning activities and effective interactions between students and teachers to improve activities and learning outcomes (Asrial & Ernawati, 2020). This research is expected to be a part of developing critical thinking skills through guided inquiry-based cladistic e-worksheets. Based on this study the purpose of this study is analyze the development of Guided inquiry-based cladistic worksheet websites in high schools towards thinking skills.

Research Method

The research method used in this study is a pre-experimental research method with a one-group pre-test post-test design. Participants in this study included the 10th grade high school students of 14 high school Bandung. The instruments used are critical thinking skills tests, cladistic e-worksheets, and validation sheets. The critical thinking skills instrument was developed using Ennis's indicators of critical thinking skills (1993). Then, these indicators develop questions in the form of essays. The results of the questions validated and judged by expert lecturers. The results e-worksheet validation in the form of numbers converted into percentages for each aspect and then compared with the predetermined eligibility categories.

The critical thinking skills instrument was tested for validity and reliability using SPSS. The validity test results on each item obtained a score of > 0.306 , so the measuring instrument used is valid (Taherdoost, 2018). At the same time, the reliability test of Cronbach's Alpha method (r count) is 0.801. This value is greater than the r -table so that the data is reliable. Data on critical thinking skills were analyzed by using the paired sample T-test.

Results and Discussion

This research produces a teaching material product in the form of guided inquiry-based cladistic e-worksheets on the material of classification of living things. Based on the results of research carried out on 36 students in one of the high schools in Bandung. Researchers had analyzed the development of guided inquiry-based cladistic e-worksheets on students' critical thinking skills and the process of activities during learning. The details regarding the identified aspects are as follows:

The activities of students in using the cladistic e-worksheet are arranged by adjusting the stages of the guided inquiry learning model. The components on this e-worksheet website include materials, cladogram-making activities, quizzes, and student grade reports. The initial view or homepage on the e-worksheet and students using the cladistic e-worksheet are shown in Figure 1.



(a)



(b)

Figure 1. (a) Initial display; (b) The use by students of the guided inquiry-based cladistic e-worksheet website.

After making the cladistic e-worksheet, a validation test was conducted by an expert lecturer. Validation was reviewed from several aspects, such as the application of guided inquiry, the relevance between activities and curriculum, aspects of competence, aspects of knowledge construction, and aspects of practical analysis. The validation analysis results can be seen in Table 1.

Table 1. Results of Validation Aspect Analysis (Pratiwi et al., 2021).

Aspect	Indicator	Score max	Score	Aspect	Indicator	Max Score	Score
Application of guided inquiry on cladistic e-worksheet(Sukma et al., 2015)	Initiation	1	1	Competence(Anderson & Krathwohl, 2001)	Observation ability	3	2
	Selection	1	1		Transformation	3	3
	Exploration	1	1		Interpretation	3	3
	Formulation	1	1		HOTS Ability	3	3
	Collection	1	1	Percentage		91.6%	
	Presentation	1	1	Knowledge Construction(Novak & Gowin, 1984)	Title/Aim/focus question	3	2
Percentage		100%			Phenomenon objects can be identified	3	2
Practical Analysis	Tools and materials according to school standards	3	3		Concepts and principles	3	2
	Clear unit tools and materials	3	3		Data recording and transformation	3	3
	Structured work procedures	3	2		Knowledge acquisition	3	3
	Data recording table according to object	3	3		Percentage		80%
Percentage		91.6%		Relevance of activities and curriculum	Competence with KD	2	2
				Content with KD	2	2	
Percentage		91.6%		Percentage		100%	

The validation test result show that based on the aspects of the application of Guided inquiry on the cladistic e-worksheet, 100% is obtained. It can be interpreted as the cladistic e-worksheet by the indicators in the guided inquiry stage. The stages are initiation, selection, exploration, formulation, collection, and presentation. Guided inquiry-based learning can develop critical thinking skills because it can help students to develop skills to interpret, analyze, evaluate, conclude and explain (Facione, 2015; Wale & Bishaw, 2020). This starts from finding the link between the concepts. The selected experiment can cause cognitive conflicts for students. At the beginning of the event a pretest is given, the procedure is in the form of giving several questions to find concepts, collect data and make conclusions. Students make hypotheses, collect data and make conclusions with their group members. As well as guiding students with questions that allow them to think independently (Kaltakci & Oktay, 2011). The process stages in e-worksheets can clarify the relationship between the representations that are built for learning outcomes. This understanding can also inform better instruction regarding the existence of misconceptions in a learning material (Matuk & Uttal, 2020).

The results of practical analysis obtained 91.6%. This means that tools and materials are easy to find around the school. Tools and materials use precise units. Then the work procedures are structured and do not cause multiple interpretations for students. In addition, the data recording table is by the phenomenon object so that it is easy to interpret. It makes it easy for students to work on Guided inquiry-based cladistic e-worksheets. Students can identify other knowledge that supports graph interpretation (quantitative data). This problem

can be proven by interpreting a cladogram to see kinship relationships, evolutionary sequences and other interpretive processes. Students need to understand data interpretation skills, these skills are related to understanding and giving meaning to observational data (Murni et al., 2017). The following result is an analysis of the competence aspect. The validation obtained a value of 91.6%. Indicators that contain aspects of competence, such as the ability of students to make an observation, then transform data from numbers into cladogram images. After that, interpret the results of the cladogram to conclude and can answer the level of higher-order thinking skills. Guided inquiry-based cladistic e-worksheet in the construction of knowledge, obtained a value of 80%. This aspect contains several indicators, such as the presence of a title/objective/question. Then the existence of object phenomena, the relationship between theories, principles, and concepts, recording and transforming data, and acquiring knowledge. The knowledge construction aspect has the lowest value among other aspects because the e-worksheet activity does not use the original object but the image on the e-worksheet. The last aspect is the suitability or relevance to KD obtained 100%. This is because the competencies developed in practical activities meet KD standards. Competencies are listed in the 2013 KD 4.3 curriculum which contains Compiling a cladogram based on the principles of classification of living things (Kemendikbud, 2013).

The students' critical thinking ability test questions were tested using 5 questions developed based on critical thinking indicators. The indicators are giving simple explanations, building basic skills, concluding, and making further explanations, strategies, and tactic (Ennis, 1993; Hikmawati, 2020). The results of acquiring the value of critical thinking abilities are in Table 2.

Table 2. Results of Students' Scores on Critical Thinking Skills

No	Indicator	Max score	Average	Percentage	Category
1	Simple Explanation	4	3.2	81%	Very good
2	Conclude	4	2.9	73.6%	Good
3	Strategy and Tactics	4	2.6	65%	Good
4	Building basic skills	4	2.8	68.7%	Good
5	Make further explanation	4	2.3	58.6%	Enough

The results of the data analysis Table 2 showed the various categories for each indicator. The simple explanation indicator reached 81% in the very good category. The indicator concludes 73.6% with the good category. Indicators of strategy and tactics reached 65% in the good category. Indicators of building basic skills reached 68.7% in the good category, and the indicators provided a further explanation for the achievement of 58.6% in the Enough category. The data from the analysis of the increase in skills offered by students' critical skills the critical skills of students after learning are in Table 3.

Table 3. Data Analysis of N-Gain Critical thinking skills

No	Information	Number of participants	Average	Category	N-Gain	Category
1	Pretest	36	32.5	Low	0.54	Currently
2	Posttest	36	69.58	Well		

Table 3 showed that the number of participants in both pretest and posttest is 36 people. The average value of the pretest score is 32.5 in the low category. This is because of the difficulty of students to interpret images and experience misconceptions. students have difficulty interpreting cladogram images, students also experience misconceptions when interpreting the relationship between each species based on kinship (Eddy et al., 2013; Julaha S, 2019; Rustaman, 2019). Meanwhile, the average posttest score was 69.58. In



general, there is an increase in students' average critical thinking skills reaching 0.54 in the medium category. This showed that the cladistic e-worksheet can improve students' critical thinking skills.

The critical thinking skills possessed by students were generally categorized as good. However, one indicator has a very good category, namely the simple explanation indicator. This is because there are several sections in the cladistic e-worksheet, such as focusing on questions and analyzing arguments. It is stated that one of the sub-indicators contained in a simple explanation is the ability of students to focus questions, analyze arguments and ask and answer questions about a challenge (Ennis, 1993). Focus on questions and analyze arguments are reflective and reasonable thinking to determine a decision (Ennis, 2018). However, students who have the lowest category on indicators make further explanations. In the questions, students are asked to compare the available data with literature sources and explain their kinship. Students consider this problem to be quite difficult, and they are not accustomed to including reliable sources of literature to make an argument. Research conducted by Rustaman, (2019) in a cladistic approach activity that produces a cladogram, students are challenged and invited to make an observation, identify and determine a number of characteristics obtained. This experience can play a role in equipping them to reason, think flexibly, think critically and practice making decisions (Rustaman, N.Y 2005; 2011; 2015; 2019).

The learning process is also observed. Several aspects are observed, starting from the teaching and learning process, the efforts of learning activities, evaluations carried out by teachers, and the obstacles faced during the learning process. The first thing that has been analyzed is how the learning process is carried out in the classroom. The observation class conducts learning using Blended learning. Class management is very good because students easily use cladistic e-worksheets during the learning process. However, students in Zoom Meetings are less actively involved in learning activities. The study result showed that only 50% of students were fully involved, and 33% were actively involved. Meanwhile, the other 17% were less active students and did not participate in online learning (Anugrahana, 2020). In the class, more than 50% of students (18 students out of 36 students) answered the questions raised. Efforts are made in learning activities to develop critical thinking, such as reinforcing learning activities carried out by the teacher concerned. Such as giving reinforcement to students who hesitate to answer, The example gave is very precise. It also gives points to students who can answer the questions.

Research conducted showed that the technique of providing reinforcement affects student learning outcomes (Fitriani et al., 2014). In learning activities, students define the nature and parameters of the problem. Students share their opinions about the hypotheses that will be prioritized. The teacher provides opportunities for students to determine the steps by the hypothesis that will be carried out. The teacher guides students to sequence the experimental steps. Encourage students to choose the right tools and materials needed. Implement a plan to solve the problem. Use science process skills to collect and analyze information. Conduct observations, collect data Communicate, and cooperate with other group members. Students organize data and make conclusions and communicate the results of the investigation. Based on these results, the development of guided inquiry-based cladistic e-worksheets can be used as an alternative for learning biology, especially the classification of living things. Teachers can also apply guided inquiry-based cladistic e-worksheets learning in the classroom but should bring direct observation animals in the classroom to make the student identification process easier. In addition, various other biological concepts can be tried to be developed using e-worksheets by carrying out further development.



Conclusion

Based on the results of the analysis, it can be concluded that the use of Guided inquiry-based cladistic e-worksheets after validation tests by expert lecturers was obtained from various aspects, such as the application of Guided inquiry to 100% cladistic e-worksheets, practical analysis obtained 91.6%, competency aspect analysis of 91.6%, knowledge construction, obtained a value of 80 and conformity or relevance to KD 100%. This means that the Guided inquiry-based cladistic e-worksheet is feasible to use. In addition, there is an increase in critical thinking skills. This is evidenced by acquiring of an N-Gain value of 0.54 with moderate criteria. So that the development of the Guided Inquiry-Based Cladistic E-worksheet can improve the critical thinking skills as in simple explanation, conclude, strategy and tactics, building basic skills, make further explanation of students in high school.

Recommendation

Despite the limitations of the study, there are still opportunities for researchers. Especially for those interested in conducting further research on the development of e-worksheets in different places with different timescales, as well as other aspects of skills that can be researched to see broader and more varied results. In addition, this study provides positive results on critical thinking skills. This development can be used by teachers for classroom learning.

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