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Increasing Critical Thinking Ability of Students Through Guided Inquiry Model in Learning Photosynthetic Materials in SMA PGRI Pekanbaru

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A B S T R A C T

The educational challenges of the 21st century require skills especially in Creativity and Innovation, Critical Thinking and Problem Solving, Communication and Collaboration. The purpose of this research is to show the improving of students' critical thinking ability of class XII High School PGRI on Photosynthetic material by using a model of Guided Inquiry. The type of this research is quasi experiment using two classes. Experiment class used model learning Guided Inquiry model and control class used conventional model. The design of research used pretest-posttest control group design. The techniques of collection the data was by using cognitive ability tests of critical thinking in pretest and posttest. From the 5 aspects on critical thinking skills: (1) elementary clarification has increased with N the gain; 0.49 (category medium), (2) basic support has increased with N gain 0.66 (moderate category); (3) inferring has increased with N gain 0.58 (moderate category); (4) advanced clarification has N gain 0.39 (moderate category); (5) strategies and tactic are experiencing increased by 0.05 gain N (low category). Generally, it can be concluded that the skill of students' critical thinking in SMA PGRI has increased through photosynthesis learning with the Guided Inquiry model.

1. Introduction

The challenges of 21st century education require skills, especially in terms of: Creativity and Innovation, Critical Thingking and Problem Solving, Communication, and Collaboration (Siti, 2016). Schools as institutions that are responsible for producing students who are creative, innovative, think critically and are able to communicate science well, therefore need to carry out active

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learning by using innovative learning models. According to Turiman, (2012) 21st century skills consist of four main domains namely the digital era of literacy, inventive thinking, effective communication and high productivity.

Science education in Indonesia is still lagging behind other countries, this can be seen from the results of the Program for International Student Assessment (PISA) in 2015 Indonesia's ranking is still relatively low for Science 64 out of 72 countries (Balitbang Kemendikbud, 2016). This is also evident from the results of the National Examination especially in Riau Province in the field of biological studies which is still low, namely in 2015/2016 it was 55.98; 2016/2017 is 46.43 and 2017/2018 is 48.06. For this reason, there needs to be an improvement in the science learning process so that it can improve learning outcomes. The learning process is inseparable from the teacher's role, therefore the teacher must be able to invite students to be actively involved in learning activities. This is in line with the opinion of Rusman (2012) that a teacher must be able to become an educator, guide and can create an interesting learning atmosphere, making students think critically. Students who have the ability to think critically will make students active, this is in accordance with the opinion of Anisa (2015) that the guided inquiry method increases student activity and increases students' critical thinking. Critical thinking according to Ennis (2009) with indicators, namely (1) provides a simple explanation (elementary clarification); (2) building basic skills (basic support); (3) making inference (infering); (4) make further clarification (advanced clarification); (5) managing strategy and tactics (Indrawati, 2012).

Teachers who are professional in improving the quality of education in schools, have the characteristics of understanding and being able to use various learning models. The use of various learning modes can improve the quality of thinking and creativity of students. Teachers who only use lectures do not create active learning. According to Putri (2013) learning using lectures is less effective because learning is only one-way between teachers and students.

According to Trianto (2009) learning model that can show the activeness of students is a discovery or inquiry model. Guided Inquiry Model means a learning activity that involves all students' abilities to find and conclude a problem systematically, logically, analytically, so with guidance from the teacher they can formulate their own findings with confidence (Gulo, 2008; Jacobsen 2009). Therefore, through the Guided Inquiry model, which requires students to be active in the learning process, it is believed that they will be effective in increasing their ability to think critically and be scientific.

Photosynthesis material is one of the materials contained in class XII biology learning that deals with light reactions, dark reactions, factors affecting photosynthesis, photosynthesis processes and the results of photosynthesis. The author's experience in the teaching and learning process on photosynthesis material students have difficulty because the reactions in photosynthesis involve biochemical reactions and the material is abstract so students are required to think critically. But in reality students are still lacking in critical thinking which has an impact on learning outcomes in photosynthesis material. In line with the opinions

of Kose, (2008) and Rahmi (2013) students experience difficulties and misunderstandings in photosynthesis material. This is thought to have an impact on UNBK results on photosynthesis material which decreased in 2014/2015 amounted to 98.78, in 2015/2016 amounted to 40.79 and experienced an increase but only slightly in 2016/2017 amounted to 52.38 and in 2017 / 2018 amounted to 55.00. To improve the results of the UN, the school held a Try Out (TO) which turned out to be also low in photosynthesis material, namely in 2015 at 16.67, in 2016 at 25.27, in 2018 at 28.00.

Based on the above background, the formulation of the problem in this study are: How to increase students' critical thinking through the application of the Guided Inquiry model in photosynthesis material. Critical thinking skills are one of the skills that students need to master. Critical thinking skills are skills and tendencies to make and assess evidence-based conclusions (Eggen & Kauchak, 2012). Marsh (1991) quoted by Ngalimun (2017) clarifies that inquiry has been used as a synonym for Inductive Thinking, Problem Solving, Discovery, and Critical Thinking.

The link between inquiry learning and critical thinking skills is explained by Massaro (2007) who states that identifying problems, gathering data, analyzing sources of information, making reasons, concluding, and evaluating can hone critical thinking skills. Critical thinking of students to be measured is according to Ennis with indicators, namely (1) giving a simple explanation (elementary clarification); (2) building basic skills (basic support); (3) making inference (infering); 4) make further clarification (advanced clarification); (5) managing strategy and tactics

Learning models that can involve students to solve and find problems are guided inquiry models. Gulo (2008). The main purpose of learning with inquiry models is to develop students' attitudes and skills so that they can become independent problem solvers (Ngalimun, 2017).

The purposes of this research is to analyze the improvement by using the Guided Inquiry learning model for critical thinking skills in Pekanbaru PGRI High School.

2. Methodology

The type of research was a quasi-experimental type. This study used two classes, one class as an experimental class and one class as a control class. The research design used was a pretest-posttest control group design. According to Sugiyono (2014), the design of this study consisted of two groups chosen randomly. The ability of both groups was measured by pretest before treatment and posttest after treatment. The research site of the Pekanbaru High School PGRI was conducted in the odd semester of april 2018 to October 2019.

The study population was all students of the Pekanbaru PGRI High School in 2018/2019 Academic Year. The research sample consisted of 55 students in each class consisting of 34 Mathematics and Natural Sciences 1 students and 34 students of Mathematics and Natural Sciences Class 2 as many as 21 students. The sampling technique was total sampling. The parameter used in this study was the cognitive ability of students' critical thinking with data collection techniques using cognitive tests of critical thinking skills in the form of pretest and posttest. The data collection instrument is an instrument of students' critical thinking abilities. Data Analysis Techniques used analyzing the cognitive abilities of students' critical thinking. Cognitive ability cognitive test instrument was analyzed in the form of objective questions. Data analysis was performed using the N Gain formula including data on test results aimed at obtaining learning outcomes using guided inquiry before and after learning with the following formula:

$$N\ gain = \frac{postestskor - pretestskor}{idealskor - pretestskor}$$

From the gain index value obtained interpreted and analyzed descriptively by using the criteria as in the following table 1.

Table 1. Category of ***N-Gain***

Koefisien	**Category**
N-Gain > 0,7	High
$0,3 \leq$ *N-Gain* $\geq 0,7$	Medium
N-Gain < 0,3	Low

3. Results and Discussion

Critical thinking of students to be measured is according to Ennis with aspects, namely (1) giving a simple explanation (elementary clarification); (2) building basic skills (basic support); (3) making inference (infering); 4) make further clarification (advanced clarification); (5) managing strategy and tactics.

Cognitive ability of critical thinking is measured by pretest and posttest questions. Before the pretest, the questions were tested on grade XII students in different schools to measure reliability, validity, different power, and level of difficulty using Anatest.

Measuring cognitive abilities of critical thinking is held pretest before the treatment is implemented. After 6 meetings with treatments using the guided inquiry model in the experimental class and the conventional model in the control class a posttest test was performed to see the success in cognitive abilities of critical thinking on photosynthesis material. The results are showed in Table 2.

Table 2. Achieving Aspects of Students' Critical Thinking Abilities by Using a Guided Inquiry Model in Photosynthesis Material at SMA PGRI Pekanbaru

Aspects of critical thinking	**Control**				**Eksperiment**			
	Pretest	**Postest**	**N Gain**	**Category**	**Pretest**	**Postest**	**N gain**	**Category**
1.*(elementary clarification)*	28,17	34,92	0,09	Low	30,88	65,19	0,49	Medium
2.*(basic support*	9,52	30,95	0,24	Low	8,82	69,12	0,66	Medium
3. *(infering)*	26,19	35,71	0,13	Low	25	8,38	0,58	Medium
4.*(advanced clarification)*	28,57	50	0,30	Medium	19,12	1,47	0,39	Medium
5.*(strategies and tactic)*	40,48	23,81	-0,28	Low	36,76	54,41	0,28	Low
Average	26,66	33,33	0,09	Low	26,47	64,41	0,52	Medium
t count	2,068				11,68			
Significant	0,52					0,00**		

** very significant with α 0.05

The experimental class has an increase in students' critical thinking skills seen from the average post-test score of 64.41 and the average pretest of 26.47 with an N gain of 0.52 in the medium category. Likewise with the control class cognitive abilities of critical thinking, the average post-test increased more than the pre-test average of 33.33 post-test and the average pretest-26,66 with an N gain of 0.09. It can be concluded that there is a significant increase in the cognitive abilities of students 'critical thinking by using guided inquiry learning models. This is in accordance with the results of Irham's research (2016). The application of guided inqury learning models has a significant influence on students' critical thinking abilities.

From the data processing cognitive abilities of critical thinking obtained aspects provide a simple explanation of an increase with n gain 0.49 in the medium category. Aspek membangun keterampilan dasar mengalami peningkatan dengan n gain 0,66 kategori sedang. Concluding aspects increased with n gain 0.58 in the medium category. The aspect of making further explanation has increased with n gain of 0.39 in the medium category. Whereas Aspects of managing strategy and tactics have increased with n gain of 0.28 in the low category.

The guided inquiry learning model includes 1) acceptance and definition of the problem, 2) hypothesis development, 3) data collection, 4) hypothesis testing and 5) drawing conclusions. The link between inquiry learning and critical thinking skills is explained by Massaro (2007) who states that identifying problems, gathering data, analyzing sources of information, making reasons, concluding, and evaluating can hone critical thinking skills. And Nurhayati's opinion (2016):

Based on the results of the study it can be concluded that the critical thinking ability of students can be empowered and developed through guided inquiry learning. Critical thinking categories that can be taught to students through guided inquiry learning include (a) deducting theories to support hypotheses (b) making problem formulations and hypotheses (c) inducing or collecting data through observational or experimental activities (d) analyzing experimental data (e) drawing conclusions (f) communicating observational or experimental results.

The first stage of the Guided Inquiry model is the problem given to students gives the opportunity for students to think critically how to solve the problem given by the teacher. Stages of acceptance and problem definition relate to aspects of critical thinking that is providing simple explanations where students analyze arguments, focus questions, ask and answer questions. Providing simple explanations is done by students after being given a problem by the teacher by making questions that arise and looking for answers to these questions. This can make students think critically connecting one concept to another so students can explain the problems given by the teacher. The guided inquiry learning model makes students willing to learn, given the questions students are motivated to think critically, cooperate in groups, increase mastery of concepts (nursafiah, 2015).

Hypothesis is a temporary answer to a problem that is still presumptive because it still must be proven true. Making hypotheses can train students to think critically because they have to make an opinion to answer a problem. Making hypotheses is related to critical thinking, namely providing a simple explanation on the indicators analyzing arguments. According to Sri Widoretno (2016): The Guided Inquiry Strategy trains the skills of developing hypotheses better than the control class. Arranging a hypothesis is a high-level thinking process, because the hypothesis is indicated from a product of an activity plan that is able to be compiled by students.

Stages of collecting data students work together to find the data needed to solve problems and test hypotheses that have been made by students. Collecting data is related to critical thinking, namely building basic skills where students consider whether the source can be trusted. And make further explanation after the data collected with the data collected can make further explanation of the existing problems. Activity to collect data students read various sources of reading and work together in groups. Stages of hypothesis testing, students are required to think critically prove the hypothesis that has been prepared. Relationship with critical thinking that is on aspects of managing strategy and tactics by determining an action. To prove the hypothesis that has been compiled students do pratikum. In doing pratikum, strategies and tactics are needed to hone the students' critical thinking skills, where the cogniitive level is at the level of creation.

Stages make conclusions that can train students' critical thinking related to the aspect of inferring. In compiling conclusions students must have concepts that are understood and understood by students and put together into a conclusion of the material learned at that time. Tri Wuryani research results (2014) Learning using

inquiry methods can improve student learning outcomes, in the form of the ability to make conclusions of information that is heard and can increase student activity.

Each stage in guided inquiry requires students to think critically, this is in line with Nursafiah's opinion (2015) guided inquri learning model is very fun, trains students to work independently, helps the process of critical thinking, and helps students in understanding photosynthetic material and can create a learning atmosphere active one. Irham (2016) Guided inquiry learning model influences students' critical thinking skills because it involves students actively in discussions and experiments so they can understand the facts and concepts of the material being studied.

Critical thinking clearly requires interpretation and evaluation of observations, communication, and other sources of information, also requires skills in thinking assumptions in asking questions that are relevant in drawing short implications in thinking and debating issues continuously continuously (Fisher, 2008). An abstract photosynthetic material requires the ability to understand the photosynthesis process which involves many chemical reactions. The light reaction process requires water that is broken down with the help of sunlight to produce ATP, NADPH followed by a dark reaction to produce glucose. To prove the results of light and dark reactions, a practicum is performed so that students see the results of photosynthesis directly by comparing several treatments and writing the experimental results into a table and making a graph, whereas in the control class with the lecture method students get more from the teacher.

From the results of the study it was seen that there was an increase in students' critical thinking skills by using the Guided Inquiry model in photosynthesis material. Critical thinking skills achieved by students in every aspect have increased, this is described as follows:

1. Giving a simple explanation

In this aspect the researcher analyzes the indicators focusing questions with two sub-indicators found in problem number 1,2, analyzes the argument with four sub-indicators contained in problem numbers 3,4,5,6, asks and answers questions with two sub-indicators contained in the problem numbers 7,8,9,10. From the answers of students in the experimental class increased with the value of N gain = 0, 49 in the medium category and for the control class the value of N gain = 0.09 in the low category. There is a difference in the results between the experimental class using the guided inquiry model and the control class.

2. Building basic support

In this aspect the researcher analyzes the indicator considering whether the source can be trusted with 2 sub-indicators contained in questions no. 11 and 12. The sub-indicator considering the use of appropriate procedures is in problem number 11 displayed an image of the Ingenhouz experiment where students must know the Ingenhaouz experimental procedure that produces a coil air because photosynthesis produces O2.

The ability sub-indicator gives the reason contained in problem number 12 where students must master the Sach and Ingenhouzs experiments so that students can make equations from the two experiments. The ability to build basic skills students are expected to have a basic knowledge to be developed further. The test results of students building basic skills showed an increase where the value of N gain was 0.66 (medium category) for the experimental class and N gain was 0.24 (low category) for the control class. In accordance with the results of Munadhiro's research (2016) The quality of basic skill building skills using guided inquiry models in the hydrolysis material belongs to the good category with an average score of 49.87.

3. Inferring

The concluded aspect is elaborated in the induction indicator and considers the induction result. Induction is a method of thinking that starts from the rules (things or events) specifically to determine the general law (rules) (Big Indonesian Dictionary). One of the characteristics of critical thinking is being able to draw generalization conclusions from the data that has been available with data obtained from the field. (Nur fatin, 2018)

Concluding indicators are broken down into four sub-indicators namely: expressing conclusions and hypotheses found in problem number 13 students understand the conclusions of the Ingenhouzs experiment. The second sub-indicator found the hypothesis found in problem number 14 where students understand the process of photosynthesis can determine factors that are not needed for photosynthesis.

The third sub-indicator is to design experiments contained in problem number 15 where students have designed photosynthetic experiments and carried out experiments. Presented tools and materials for carrying out the Sach experiment to prove the presence of starch as a result of photosynthesis.

The fourth sub indicator is to draw conclusions from the probing results, contained in problem number 16. Students understand the CO2 needed in the photosynthesis process by experimenting with adding Na HCO2 (baking soda) to increase CO2 levels so that many air bubbles are produced, students are expected to be able to draw conclusions if CO2 levels are reduced in the air then the first to get an impact are producers or plants. From the test results for the aspect of concluding increase, the N gain of the experimental class was 0.58 with the medium category and the N gain for the control class was 0.13 with the low category. The same thing can be seen in the results of Yusi's (2016) indicator, which concluded that there was an increase of 0.4 (moderate category).

4. Making advanced clarification

Making advanced clarification consists of defining terms and considering an indicator definition and sub-indicators make the form of deviation contained in questions number 17 and 18. Definition is the formulation of the scope and characteristics of a concept which is the subject of discussion or study (KBBI,

2008). In question number 17 students are required to understand the concept of factors that influence photosynthesis and in question number 18 students are required to understand the concept of the Sach experiment. The aspect of making further explanation has seen improvements in N experimental class gain 0.39 (medium category) and N control class gain 0.30 (low category). Supported by the results of research by Nadipah (2016) the ability to provide further explanation using the guided Inquiry learning model included in the sufficient category.

5. Managing Strategies and tactics
The action and is described in two sub-indicators which reveal the problem found in problem number 19 where students understand that photosynthesis produces carbohydrates whose fuel comes from the air and from the soil.

The second sub-indicator which is choosing criteria to consider the solution that might be found in problem number 20 where students understand to test the production of glucose in the photosynthesis process is done by dropping leaves with iodine solution. The aspects of managing strategy and technique experienced a slight increase with N gain of 0.28 (low category) for the experimental class while for the control class the decrease was seen from N Gain = -0.28. In line with the results of Jiran's research (2016) indicators governing strategies and techniques as much as 53.7% are in the low category.

4. Conclusion

The results of this research can be concluded that the skill of students' critical thinking in SMA PGRI had increased through photosynthesis learning with the Guided Inquiry model. The Guided Inquiry model can be used by teachers in SMA PGRI Pekanbaru in the learning process to improve students' scientific communication skills and critical thinking in biology learning.

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