

# **The Implementation of Modified Free Inquiry Learning Model to Improve Critical Thinking Skills of 21st-Century Students in High School on Bryophyta Learning**

**Eva Faozia Rahmi, Sariwulan Diana, Ana Ratna Wulan**

Universitas Pendidikan Indonesia  
*evafaoziarahmi@upi.edu*

## **Abstract**

The 21st century demands quality human resources and is able to compete globally. Critical thinking skills are part of important competencies in the 21st Century. The use of modified free inquiry learning models is one alternative to improve critical thinking skills and facilitate learning of Bryophyta. Bryophyta learning contains complex material. This study aims to apply the modified free inquiry learning model in improving the critical thinking skills of the 21st Century high school students in Bryophyta learning. The research method used a quasi-experimental method with non-equivalent control group pretest posttest research design. The sample used two classes consisted of modified free inquiry class and conventional class. The instruments Instrument consists of questions about pretest and posttest critical thinking skills, student worksheet, observation sheets and questionnaire. The results showed that there was an increase in critical thinking skills in the experimental class students by (0.51) in the medium category and the control class students by (0.75) in the high category. Increases occur in all indicators of critical thinking skills. The results of the questionnaire showed that students responded positively to the application of modified free inquiry learning models in improving 21st Century critical thinking skills in Bryophyta learning.

**Keywords:** thinking modified free inquiry, 21st-Century critical thinking skills, Bryophyta Learning

## **1. INTRODUCTION**

21st century skills are skills, knowledge, and expertise that must be possessed and mastered by students in order to succeed in life in the 21st century (P21, 2018). 21st century skills in particular focus more on four skills students must possess, namely critical thinking, creative thinking, collaboration skills, and communication skills (P21, 2012). 21st century skills are very important to be able to live successfully in facing the challenges of the 21st century (Lewin & McNicol, 2015). A person's ability to think, solve problems, and learn, has a greater impact on a person's ability to function in a society that is full of technology than someone who only has knowledge (Ananiadou & Claro, 2009).

The development of 21st century skills can be an important life skill in equipping each individual to be able to adapt well in the life of the 21st century. In the 21st century, competencies needed are generally related to the development of cognitive aspects that include the ability to think critically, analytically, and solve expected problems become a key indicator of success (Ontario, 2016). 21st century skills that are essential are critical thinking skills (P21, 2018).

Critical thinking skills relate to the ability of individuals to think systematically, analytically, and are able to solve problems, and find the best alternative solutions in their efforts to solve them (P21, 2018). Although critical thinking

skills are important skills in facing life in the 21st century, the data shows that the critical thinking skills possessed by students in Indonesia have not developed optimally. Critical thinking skills possessed by students in Indonesia are still categorized as low. It can be seen that the research data shows that the value of critical thinking skills possessed by students in Indonesia is 16.49 out of 100 (Aloysius, 2013; Gultom, 2014).

In this study, it was designed to apply the model of the application of modified free inquiry learning models in Bryophyta learning. This is based on the complexity of Bryophyta material especially difficult in identifying its morphological structure. Bryophyta is a plant that has not been able to distinguish roots, stems and leaves. To understand it requires a deep understanding and involves high thinking skills. Therefore, the use of a modified free inquiry learning model is deemed appropriate to be applied in Bryophyta learning and this research is still rarely done.

## **2. MODIFIED FREE INQUIRY**

Modified free inquiry is a modified learning model of guided inquiry and free inquiry (Sund & Trowbridge, 1973). In the implementation the teacher first provides further problems students make formulation of the problem, submit hypotheses, plan and conduct experiments, analyze data,

communicate and conclude independently (Bonnstetter, 1998).

### 3. 21ST-CENTURY CRITICAL THINKING SKILLS

Critical thinking is a process that aims to form rational decisions and reflective thinking processes that focus on the patterns of decision making about what is believed and done (Ennis, 1985, 1995). Critical thinking is a way of sharpening deep thought processes by using analysis to process experiences and problem solving (Facione, 2013). In teaching critical thinking, one must be given the opportunity to try and think, dare to prioritize different arguments, give reasons, and explore new things (Wu, Gennari, Huang, Xie, & Cao, 2016). There are four indicators of effective thinking skills, thinking systems, giving consideration and make decisions, and problem solving (P21, 2012).

### 4. BRYOPHYTA LEARNING

Bryophyta is a group of plants that have no vessels. Bryophyta is a transitional form between Thallophyta and Cormophyta (Campbell et al., 2012). Moss is classified into 3 divisions, namely liverworts (Hepaticophyta), hornworts (Anthocerotophyta), and leaf moss (Bryophyta). Hepaticophyta has a body shape in the form of sheets, flat, and lobed, and has a flat shaped gametophyte and grows horizontally (Bidlack & Shelley, 2014). Examples of moss plants are *Marchantia*, *Lanuaria*, and *Jungermannia* (Campbell et al., 2012). Characteristics possessed by hornworts, including long and tapered sporophytes, sporophytes do not have a seta and only consist of sporangium. Examples of hornworts are *Anthoceros punctatus*, *Phaeoceros laevis*, *Folioceros*, and *Leiosporoceros* (Campbell et al., 2012). Leaves or true mosses have a body shape from leaf moss usually like small plants and upright, have sporophytes that are elongated and can be seen directly without the aid of aids. Examples of leaf moss are *Polytrichum commune*, *Polytrichum hyperboreum*, *Sphagnum palustre*, and *Dichodontium* (Campbell et al., 2012).

## 5. EXPERIMENTAL DETAIL

### 5.1 Method

The research method used a quasi-experimental method with non-equivalent control group pretest posttest research design.

### 5.2 Participant

The participant in this research used was 2 classes consisted of modified free inquiry class and conventional class at SMAN 1 Garut.

### 5.3 Instruments

The instruments used were in the form of questions about pretest posttest, student worksheet, observation sheets and questionnaire.

- a. Questions about pretest posttest  
The test used to measure students' critical thinking skills before and after Bryophyta learning. The form of the questions made in the form of open ended.
- b. Student worksheet  
Worksheet as a learning tool that serves as a guide for student observation activities.
- c. Observation sheets  
The observation sheet of the implementation of the modified free inquiry learning model as well as the conventional learning model was used to assess the feasibility of each stage of learning carried out by the teacher and students.
- d. Questionnaire  
Descriptions of student responses to the modified free inquiry learning model in Bryophyta learning.

### 5.4 Procedure

Participants will be tested with pretest questions about critical thinking skills before learning begins. Then learning activities are carried out in accordance with the syntax of the modified free inquiry model in the experimental class and conventional learning models in the control class. Learning activities assessed by observers. At the end of the learning activity, students are given a posttest about critical thinking skills. Experimental class students were given a questionnaire response to the implementation of a modified free inquiry learning model in Bryophyta learning.

## 6. RESULTS AND DISCUSSION

### 6.1 The Implementation of a Modified Free Inquiry Learning Model

The feasibility of the steps of modified free inquiry learning and conventional learning are analyzed through observation sheets. Recapitulation of the results of observations can be seen in table 1 and table 2.

Table 1. Recapitulation of the Results of Observations Modified Free Inquiry Learning

Aspects observed	Percentage of Implementation
Problem orientation	92%
Formulate problems	86%
Submit a hypothesis	86%
Planning an experiment	88%
Do an experiment	85%
Analyze data	83%
Communicate	86%
Conclude	85%
Average	86.37%

Based on the table 1, shows that the modified free inquiry learning model was implemented with a very good category. The modified free inquiry learning model consists of a series of stages of learning that can develop students' skills to think higher especially in the problem-solving process.

Table 2. Recapitulation of the Results of Observations Conventional Learning

Aspects observed	Percentage of Implementation
Preparation for observation	85%
Observation activities	83%
Presentation of observations	80%
Average	82.67%

Based on the table 2, shows that the conventional learning model was implemented with a good category. Conventional learning models in this case take the form of practical activities that are usually done for observing plants.

### 6.2 Improving Students' Critical Thinking Skills with a Modifiable Free Inquiry Learning Model and Conventional Learning Models

Improvement of students' critical thinking skills with a modified free inquiry learning model with conventional learning models including an increase in each indicator of critical thinking skills in Bryophyta learning was analyzed through N-gain. Recapitulation of increasing critical thinking skills in Bryophyta learning can be seen in table 3.

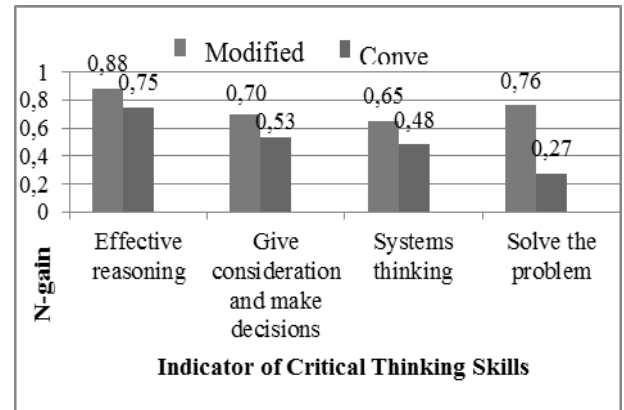
Table 3. Recapitulation of Increasing Critical Thinking Skills in Bryophyta Learning

Statistics	Modified Free Inquiry Learning		Conventional Learning Models	
	Value		Value	
	Pretest	Posttest	Pretest	Posttest
Minimum value	10	50	10	30
Maximum value	90	100	80	90
Average	52.42	88.02	42.03	66.56
N-Gain	0.75		0.51	

Based on table 3 shows that, increasing the thinking skills of modified free inquiry class students is in the range of N-

gain  $\geq 0.70$  in the high category and conventional class students are in the range of  $0.3 \leq N\text{-gain} \leq 0.70$  in the medium category. This can be interpreted that the increase in critical thinking skills between the two classes differed significantly. The percentage of Increasing Indicator Critical Thinking Skills in Bryophyta Learning can be seen in Figure 1.

Figure 1. The Percentage of Increasing Indicator Critical Thinking Skills in Bryophyta Learning

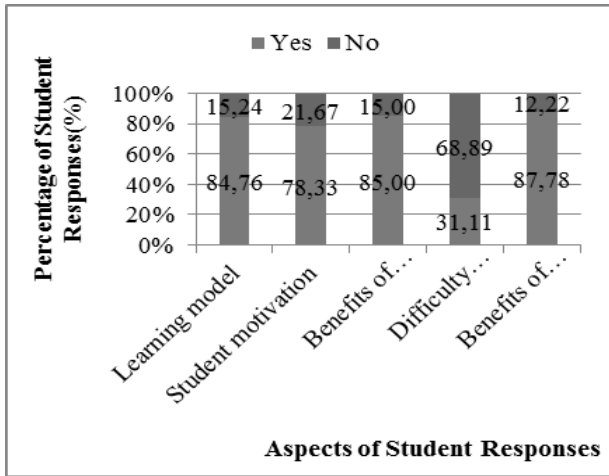


Based on Figure 1, based on table 1 shows that, the modified free inquiry class and conventional class experienced the highest increase in critical thinking skills on effective reasoning indicators and the lowest improvement of critical thinking skills in modified free inquiry class students on system thinking indicators and conventional class students on problem solving indicators. Improvement of critical thinking skills in students is caused by the influence of a series of learning stages from each applied learning model and the learning tools used. This caused the modified free inquiry class with conventional class students to experience different critical thinking skills in each indicator.

### 6.3 Student Responses to The Modified Free Inquiry Learning Model

Student responses to the application of the modified free inquiry learning model, obtained from the results of the questionnaire analysis of students' responses to the learning model used, student motivation, the benefits of the learning model, difficulties in understanding practical guidelines and the benefits of practical guidelines. Questionnaire of student responses to the modified free inquiry class in the form of an open questionnaire containing 20 statements with a choice of "yes" and "no" answers along with reasons to support the answers given. The percentage of student responses to the modified free inquiry learning model can be seen in Figure 2.

Figure 2. The Percentage of Student Responses to The Modified Free Inquiry Learning Model



Based on Figure 2. shows that student responses on each indicator have a different percentage. The response of students to the modified free inquiry learning model meaning almost all students agreed that the modified free inquiry learning model was a new learning model, the modified free inquiry learning model could train in formulating problems, formulating hypotheses, planning and carrying out experiments, analyze data and make conclusions independently. The modified free inquiry learning model could increase motivation and make learning activities more enjoyable. The modified free inquiry learning model can improve mastery of concepts and critical thinking skills.

The difficulty in understanding the practicum guide meaning that almost half of the students felt difficulties in completing the LKS, did not have enough time and difficulty in interpreting the phenogram. The benefits of practicum guidance meaning that almost all students could understand work questions and instructions in LKS, LKS made it easier to understand Bryophyta material, LKS helped improve mastery of concepts and critical thinking skills, LKS helped in making the phenogram and LKS is useful in Bryophyta learning.

## 7. SUMMARY

Based on the results of research in two classes of SMAN 1 Garut it is known that the class of students given the application of modified free inquiry learning models showed an increase in critical thinking skills that were higher than the classes given conventional learning models. This is supported by the results of the questionnaire which states that students agreed that the modified free inquiry learning can increase critical thinking skills.

## 8. ACKNOWLEDGMENT

The author would like to thanks to lecturers of the biology education programmed, Postgraduate School of Universitas Pendidikan Indonesia for the guidance during the article writing process.

## 9. REFERENCES

- Aloysius, D. C. (2013). Empowering critical thinking skills in Indonesia archipelago. *Journal of Modern Education*, 3(11), 852-858.
- Ananiadou, K., & Claro, M. (2009). 21st Century skills and competences for new millennium learners in OECD countries. *OECD Education Working Papers*, 41, OECD Publishing.
- Bidlack, J. E. & Shelley, H. J. (2014). *Stern's introductory plant biology - Thirteenth edition*. New York: McGraw Hill Company Inc.
- Bonnstetter, J. R. (1998). Inquiry: Learning from the past with an eye on. future. *Journal of Science Education*, 1(3).
- Campbell, N. A., Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Jackson, R. B. (2010). *Biologi edisi kedelapan jilid 2*. Jakarta: Erlangga.
- Ennis, R. (1985). *Developing minds, a resource book for teaching thinking chapter: Goals for a critical thinking curriculum*. USA: Association for Supervision and Curriculum Development.
- Ennis, R. (1995). *Critical thinking*. USA: The New York Times Company.
- Facione. (2013). *Critical thinking: What it is and why it Counts*. California: Measured Reasons and The California Academic Press, Millbrae, CA.
- Gultom, M. (2014). *Perbandingan strategi pembelajaran Problem Based Learning (PBL) dan inquiry dalam meningkatkan hasil belajar, kemampuan berpikir kritis, dan kreatif dalam mata pelajaran biology* (Bachelor dissertation, UNIMED).
- Lewin, C., & McNicol, S. (2015). Supporting the development of 21<sup>st</sup> century skills through ICT. *KEYCIT 2014: Key Competencies in Informatics and ICT*, 7, 181-98.
- Ontario. (2016). *21<sup>st</sup> century competencies: Towards defining 21<sup>st</sup> century competencies for Ontario*. Toronto: Ontario Ministry of Education.
- P21 (*Partnership for 21st Century Skills*). (2012). *Learn for the 21<sup>st</sup> century. A report and mile guide for 21<sup>st</sup> century skills. Partnership for 21<sup>st</sup> Century Skills*. [Online]. Retrieved: [http://www.p21.org/storage/documents/P21\\_Report.pdf](http://www.p21.org/storage/documents/P21_Report.pdf).

- P21 (*Partnership for 21st Century Skills*). (2018). *Collaboration*. [Online]. Retrieved: [www.p21.org/our-work/4cs-research-series/collaboration](http://www.p21.org/our-work/4cs-research-series/collaboration).
- Sund, R. B., & Trowbridge, L. W. (1973). *Teaching science by inquiry in the secondary school*. London: Routledge.
- Wu, T. T., Gennari, R., Huang, Y. M., Xie, H., & Cao, Y. (Eds.). (2017). *Emerging technologies for education: First international symposium, SETE 2016, Held in conjunction with ICWL 2016, Rome, Italy, October 26-29, 2016, Revised Selected Papers* (Vol. 10108). Springer.