

Simas eric Model to Improve Students' Critical Thinking Skills

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Abstract

In the 21st century critical thinking skills have become very important for students at every level of education; critical thinking is not in born and does not develop naturally. This paper explores the potential of the Simas eric model in providing a learning experience for critical thinking in students. Simas eric model dan conventional model were compared to consider the academic level of students, high academic level and low academic level, toward the increasing of students' critical thinking skill value. Test on the enhancement of students' critical thinking value was done before and after the treatment of learning model. Data analysis employed covarian (ANACOVA) and LSD test. The conclusions of the research were: 1) Simas eric model is able to improve students critical thinking skill at 140.9%. 2) High academic students were taught using Simas eric model had increasing 65.3% critical thinking skill higher than conventional class. 3) The increasing value of students' critical thinking skill with low academic were taught using Simas eric model is higher than the increaaing value of students on high academic students which were taught using conventional model.

Keywords: Critical thinking, Simas Eric.

1. Introduction

Some of the skills needed in the 21st century competencies include problem solving, critical thinking, communication, collaboration and information literacy (NGSS Lead States, 2013; NRC, 2012; Griffin, 2012; OECD 2013). Scientific literacy and critical thinking are key components in preparing students to live in an era of science and technology (Vieira, 2014). Thinking must be habituated and familiarized to students to avoid the bias, partial, distorted and lack of literacy. This will affect the quality of life and productivity that depends on the quality of thought (Paul, 2006). These statements underlying the importance of engaging students to think critically, familiarize the ability, argue based on evidence and provide a scientific explanation (Lin, 2013).

Based on Bunce (1991), as a part of the science, Biology requires teachers to guide students in the process of thinking, formulating question, and finding an answer. Learning of Biology consists of products and the processes. Products of Biology consist of facts, concepts, principles, theorys, laws and postulates related to life-living things and their interactions with environment (Rogers at al., 2015). Biology, in terms of process, has processing skills such as: observing with the senses, classifying or grouping, applying the concept or principle, using tools and materials, communicating, hypothesizing, interpreting data, doing experiment, and asking questions. Basically, learning of Biology tries to guide students with various skill ranges about how to know and understand the concept or the fact in depth. In addition, learning of Biology should be able to provide students' pleasure and intellectual satisfaction to explore various concepts.

Through this way, the effectiveness learning of Biology can be achieved. Thus, a learning model which teaches those students' learning experiences is required to achieve an effective learning of Biology.

Another factor should be given more attention in teaching and learning process is students' academic level since it will give impact on the students abilities in learning activities. The academic level of each student is a factor that influences the process and the learning outcome. Definition of student's academic level is the degree of actual competence to perform in scholastic or educational activities (ERIC, 2013), the potential to achieve high academic standards. The academic level can be represented by IQ test scores done at the first time entering higher level of education. They reflect the students capability in answering questions which have already standardized (valid and reliable).

Fundamentally, students can be classified, in the term of the academic level and intelligence, into three levels, which are: 1) students who have below average academic ability or low academic level, 2) students who have average academic ability or average academic level, and 3) students who have above average academic ability or high academic level. The academic ability needs to be empowered, especially for students having low academic level in order to achieve the same result with those who have different ability (Corebima, 2006). Based on this different academic level, it is expected to know students achievement of critical thinking skill who have high and low academic level.

LDC can be alternative for teachers in creating learning model development. Simas eric model development, first discovered the basis of the LDC. Darmawan, et al., (2015) describes the stages of Simas eric model i.e.: (1) **SkimmIng**: fast review of the material, (2) **Mind mApping**: create a mind map, (3) **QueStioning**: asking high-level questions (why and how), (4) **Exploring**: examine the matter to answer questions, (5) **WRITing**: write down the answers to the question briefly, and (6) **Communicating**: communicate collaboratively about mindmap results, questions and answers. In detail can be seen in Table 1.

Table 1. Instructional Design of Simas eric model

Instructional Design of Simas eric model	
Learning procedures	
Phase One: Introduction	
	<ol style="list-style-type: none"> 1. Greet the students and ask them to pray before the learning begins. 2. Checking students' attendance. 3. Communicate /state the learning objectives, the expected learning outcome, and rules in learning. 4. Motivate and stimulate the students' curiosity about the related topics.
Phase two: main Activities	
Skimming	
	<ol style="list-style-type: none"> 1. Students will undertake a fast review of the material. The fast review which focuses on the title of each chapter, pictures accompanying the explanation of materials, tables, graphs, introduction, summary and ends with the conclusion. 2. Aims: Provide a comprehensive illustration of the material content in each chapter that will be studied.
Mind mapping	
	<ol style="list-style-type: none"> 1. Students creat a mind map in a collaborative group. 2. Aims: By using mindmap, students can select what kinds of information that are accepted and store it more clearly. In addition, mindmap can help students to think and to memorize better, to solve problems and act creatively. Mind map provides an encouragement for creativity and flexibility. Mindmap helps students to think outside the box. In mind mapping stage, the teacher's role as a students' guide in experiencing learning experience that allows students to discover principles and to construct their selves understanding.
Questioning	
	<ol style="list-style-type: none"> 1. Students' activity is asking questions that arise from his mind after going through previous stages. 2. Aims: students will remain to focus on reading and remembering the materials better, the questions written are not the questions which the answers are already in the summary, introduction, or conclusion. The reference materials to make high-level question is why and how. The materials that are asked are important or very important related to the reading materials. The number of the questions is tailored to the subject matter, while the whole questions were written.
Exploring	
	<ol style="list-style-type: none"> 1. Students explore the material in the chapter that will be discussed by re-reading or doing experiment if their questions require more exploration in order to answer the question which appears on their minds as well as to remember the material. 2. Aims: when answering questions, students are suggested to remain focused on the subject matter.
Writing	
	<ol style="list-style-type: none"> 1. Students are required to answer questions with making arguments. 2. Aims: able to make arguments and practice accountable.
Communicating	
	<ol style="list-style-type: none"> 1. Students were asked to present the mind mapping they have made before and are asked to read their own questions and answers in front of the class, while the other students are asked to give comments, feedback, or to ask questions related to each question and the answer. 2. Aims: students learn collaboratively since teachers place students in heterogeneous groups so that there is possibility of peer tutoring.
Phase Three: Closing	
	<ol style="list-style-type: none"> 1. Facilitate each group for reflection and evaluation of the learning instruction in order to be able to identify strengths, weaknesses, and choice in learning. 2. Ask the students to pray.

Some researches indicate that many high school students in Malang-Indonesia have not been taught by learning model that sharpen critical thinking skills especially in the subject of Biology (Mahanal 2009; Lilik, 2011; Fitriana, 2012; Kusumaningtias, 2013; Malahayati 2014; Wicaksono, 2014; Prasmala, 2014; Permana, 2014). One way that can be pursued to teach, develop and equip students in order to have critical thinking skills is by employing Simas eric model.

The theoretical background of Simas eric model includes: constructivism, cognitivism, connectivisme and behaviorism. Constructivist learning theory is based on the principle that knowledge is created from experience (Almala, 2005). In addition, constructivist is not a theoretical unity, rather, it is a continuum (Doolittle, 1999). Cognitivism theory according to Bruner that person as a processor, thinkers and creators of information. Bruner considers that a study includes three cognitive processes: to obtain new information, knowledge transformation, and examine the relevance and accuracy of knowledge.

This research focuses on the level of high school students' critical thinking skills. Research aims of this study are: 1) the influence of Simas eric model toward high school students' critical thinking skills, 2) the academic level influence high school students' critical thinking skills, 3) the interaction between Simas eric model and academic level to high school students' critical thinking skills.

2. Method

This study was quasy experimental research. Pretest-posttest with non-equivalent control group design was used in this study. Simas eric model and conventional learning were the independent variables of this study, while the moderator variables were the high and low academic level. Control variables of this study were the ability of teachers, number of hours, and the material presented. The dependent variable was critical thinking skills. Learning activities were accomplished in 12 weeks.

The population of the study was eleventh graders of Senior High School in Malang. The samples were done by means of random sampling. Simas eric model was carried out by one class , while another class was conventional class. There were two classes used in this research. The total number of samples was 100 students of high school students grade eleventh taken from 4 high schools in Malang, East Java – Indonesia.

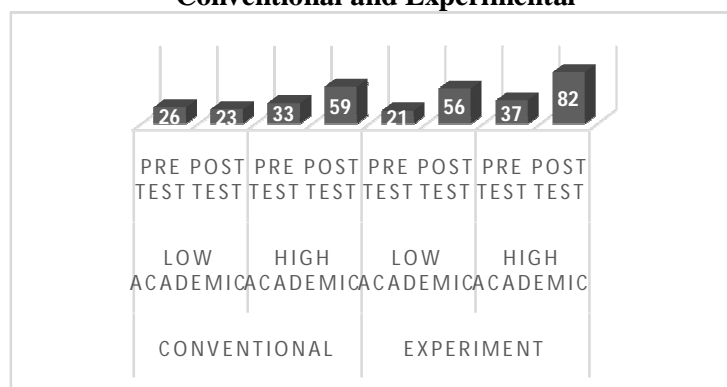
There were several steps employed in this experimental study. First, The first step was developing learning device. Before developing learning media, the researcher did a survey to know the real condition deal with the condition of critical thinking skills, students where the instrument used in the form of a questionnaire given to high school teachers in the city of Malang. Learning media then was validated by experts and teachers. In addition, a limited field trials conducted prior to experiment with lesson study activities. After that, critical thinking skills rubric was used to determine the score of critical thinking skills integrated with essay tests, in understanding of the concept. Each class was divided into academic treatment of the high and low academic level. IQ test was done by students to determine the value of academic test scores of students at the beginning of high school. Determination of the high and low academic to sort all samples based on IQ scores from highest to lowest value that consists of 50 students the first order for the top academic and 50 students last academic sequence below. High academic and low academic level in each class are used as research subjects.

Descriptive statistics was used to analyze data. Before analyzing data using Anacova, they must be tested first by assumptions Anacova that includes normality and homogeneity of variance test data. Test for normality used One-Sample Kolmogorov-Smirnov, while the homogeneity test used Levene's Test of Equality of Error Variances. It was carried out with the help of SPSS 18.0 statistical analysis program for Windows, statistical tests performed at the significance level of 0.5%.

3. Result and Discussion

The experimental research data both from Simas eric model and the conventional classes that include pre test and post test of critical thinking skills are described at Figure 1. High academic and low academic students who were taught using Simas eric model has mean score higher than conventional class in pretest and posttest.

Figure 1. Pretest and Posttest Mean Value of Students Critical Thinking Skills on the Class Conventional and Experimental



Based on the Figure 1, the data analysis of the anacova testing is explained as follows.

4.1 The influence of Simas eric model toward critical thinking skills of high school students

The results of the Anacova analysis of influence Simas eric model on critical thinking skills can be seen in Table 2. Table 2 shown that F value was 247.903 with significance value 0.0000. It can be interpreted that there was influence on the achievement between learning model application and the critical thinking skills of students.

Table 2. Summary of Anacova Test Results on the Influence of Learning Model

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	53727.861 ^a	4	13431.965	157.113	.000
Intercept	9118.565	1	9118.565	106.659	.000
Pretest_Critical thinking	8622.701	1	8622.701	100.859	.000
Class	21193.789	1	21193.789	247.903	.000
Academic	8145.999	1	8145.999	95.283	.000
Class * Academic	1950.638	1	1950.638	22.817	.000
Error	8121.779	95	85.492		
Total	363690.000	100			
Corrected Total	61849.640	99			

a. R Squared = .869 (Adjusted R Squared = .863)

Based on the test results of the LSD in Table 3, can be seen that the achievement of critical thinking skills of students in the experimental class is significantly higher than the control class. Students' critical thinking in Simas eric model increased was 140.9%.

Table 3. LSD test results on the effect of application of learning model toward critical thinking skills

Class	Average		Average Correction	Enhancement	BNT Notation
	Pretest	Posttest			
Control	29,47	40,81	40,37	38,45429 %	a
Exsperiment	28,67	69,08	69,51	140,9884 %	b

4.2 The influence of academic ability toward critical thinking skills of high school students

The results of the Anacova analysis of the influence of learning model on students' critical thinking skills can be seen in Table 2. Table 2 shown that F value was 95.283 with a significance value 0.000. Can be interpreted there was influence on the achievement levels of academic level to the critical thinking skills of students.

Based on the test results of the LSD in Table 4, it can be seen the average correction of high academic students significantly higher than low academic students. The students' critical thinking enhancement in low academic is significantly higher than students' critical thinking enhancement in high academic. Students' critical thinking in low academic taught using Simas eric model increased 102.7%.

Table 4. LSD Test Results on the Effect of Difference Academic Level toward Critical Thinking Skills

Class	Average		Average Correction	Enhancement	LSD Notation
	Pretest	Posttest			
High Academic	23.33	39.33	44.578	68.57143 %	a
Low Academic	34.81	70.56	65.302	102.7135 %	b

4.3 The Interaction of Simas eric model and academic level toward critical thinking skills of high school students

Table 2 shows that the F value was 22.817 with a significance value 0.000. It means that there is interaction between Simas eric model and academic level of the students' critical thinking skills. Based on the test results of the LSD in Table 5, can be seen that the low academic students in control class had significantly lower critical thinking skills than the other three treatments classes students, while the high academic students in the experimental class had significantly higher critical thinking skills than the other three treatments class students. The highest enhancement value of critical thinking skills in the low academic class was 171.9%.

Table 5. LSD Test Results on the Effect of Interaction Learning Model and Academic Level toward Critical thinking Skills

Treatment interaction	Average		Average Correction	Enhancement	LSD Notation
	Pretest	Posttest			
Conventional-Low	26.06	22.72	25.484	-12.7932 %	a
Conventional-High	32.89	58.89	55.257	79.05405 %	b
Experiment-Low	20.61	55.94	63.672	171.4286 %	c
Experiment-High	36.72	82.22	75.347	123.9032 %	d

4.4 Critical Thinking Skills Improvement through Simas eric Model

According Zane (2013), critical thinking skills that are intended in this study is a mental process that includes the ability to interpret, analyze, evaluate, make inferences, communicate and do self-regulation. Thinking requires logical reasoning and analytical skills and demonstrates high-level thinking (Tice, 2000). Furthermore, associated with Bloom's taxonomy, critical thinking inherents with the skills to think critically, namely analysis and synthesis. Critical thinking technically, includes: understanding the argument, recognizing that thinking is wrong, distinguishing the premise and conclusion, and separating the issue with information. The LSD testing of experimental class which implemented Simas eric model indicated an increase in the percentage of experimental class 140.9% much higher than the control class.

Accustoming students to think critically also have to be conscious and planned effort (Zane, 2013), so that in the implementation of the teaching and learning process, the teacher should be able to integrate the appropriate model to be used for the improvement of critical thinking. In order to be able to examine how Simas eric model can improve students' critical thinking skills is necessary to map and describe the interrelationship between the components of critical thinking with the syntax of Simas eric model. Skimming, students will do skimming rapidly to a material which focus on titles, pictures, tables, graphs, introduction, summary and conclusions. In this activity, the critical thinking skills that are accustomed is doing evaluation about whether or not the material is important to be studied in depth based on prior knowledge they have already had. This stage is able to encourage students self regulation, skimming is reading techniques and strategies to read textbooks or reading material and reading from the internet, so it is important for cognitive students in reading comprehension (Hong, 2013).

Mind mapping stage which requires students in making authentic work in the form of mind map so that students will perform analysis such as classifying and categorizing the learning materials, in the process of making a map of the student's mind will enable the ability to identify and examine the relationship between materials with sub-material, make the connection in the form of checklists non-linear line representing the relationship between the learning materials, process monitoring indicates the need for regulatory processes (Zimmerman, 2000). The second stage of this syntax also familiarize students to practice the skills of their self regulation to always include questions related to the ability of reflection, self-examination and self-correct. Reading is possible to convert explicit knowledge into tacit. By reading a particular subject, students learn from written references, thus converting the knowledge contained in references into tacit, knowledge in their brain (Handoko at all., 2016).

In questioning phase, students in collaborative groups will make the question in individual. In the process of making questions related to student learning material, the researcher assessed the students' understanding through skimming and mind mapping stage, self regulation and evaluation of learning while students generate high level thinking questions which arised with why and how questions.

Slavin (2009) states that the cooperative strategy to develop relationships between groups, the acceptance of classmates who were weak in the academic field, and increase self-esteem of students, thus encouraging the growth of peer tutor awareness among students. Questions raised by the students will lead students also enable the ability to perform its interpretation by trying to clarify his understanding of the subjects. The next step of Simaseric model is exploring, students read again the material carefully in attempt to answer the question. In the process of exploring those students will strive to clarify their understanding and critical reading so they can solve their questions. According to Zane (2013) part of the self regulation as students will be responsible for their own learning progress and adapt modes of learning in achieving the task demands. Self-regulation capability will also be activated for student self-reflection abilities, to self-correct and self-examination to be able to construct their understanding. Self-regulation occur when learning and problem solving, some studies show that self-regulation in learning has been used to improve academic achievement (Howse, et al., 2003; Perry, et al., 2007).

In writing stage, the process of answering the questions made by students after exploring, critical thinking skills that are expected to arise in this process is the ability of students to make conclusions, skilled analysis, and proficient in communicating. Concluded by inductive and deductive reasoning, used to make decisions, to make generalizations, and understand the connectivity between components in a material. Ability prepare, identify, and evaluate the argument is a crucial part of critical thinking (Lau, 2003). The process of writing is done in a collaborative work that allows students to skillfully communicate with friends the group to find solutions to problems that arise. Discussion process in which there are arguments, according to Lau (2003) a statement which contains summaries of exposure, premise or assumption of the argument. So that students are able to make a good argument it must be able to draw up the premise and reason to accept the conclusion.

Communicating is a class discussion conducted by individuals who work in groups. In communicating the issues related learning materials enables the process self-regulation in preparing students for understanding a subject. Able to communicate well, a critical-thinking skills to participate actively communicating activated at this stage. This refracton step for students to think critically, (Nugent, 2008) says there are at least three activities that should be familiarized namely: problem solving, decision-making, and check the answer/ diagnostic reasoning. Mind mapping, questions and answers from the student subsequently collected for the benefit of the assessment which will underlie the evaluation of the assessment which besides others. After the students read the questions and answers individually in front of the class, to continue the discussion and collaborative work in heterogeneous groups believed that various important or the most important contents of the reading material has actually been disseminated to the entire class.

4.5 The Effect of Different Academic Level toward Critical Thinking Skills

Research results indicate a significant relationship between the level of academic level of the students' critical thinking skills. The group of students of high academic level significantly to show critical thinking abilities higher than those in low academic level students. The results of this study can be explained, that the academic level is one of the factors that influence students' critical thinking skills. Gunter (2001) reported that students with high academic achievement thinking ability higher than students with low academic level. This is due to the knowledge that is used to solve complex problems involving higher cognitive has been owned by the students of high academic level. According to Gagne (1995) knowledge affects the development of students' thinking. Giancarlo (1998) and Facione (1997) reported a very close relationship between the basic thinking skills of the students in determining the success of students in critical thinking. The fact was in line with LSD test results which stated that the improvement of critical thinking kills in low academic ability students was 68.5% while the high academic students was at 102.7%.

Tice (2000) suggests that critical thinking relates to the individual's cognitive development. According to Lin (2013) critical thinking is a mental process that is well organized and play a role in the decision-making process to solve the problem by analyzing and interpreting the data in the activities of scientific inquiry.

Based on the illustration above, the role of academic level is an essential factor in improving critical thinking skills. Therefore, teachers need to pay attention to a student's academic level in learning, for academic ability affect the intellectual development of students, and the ability to apply critical thinking (Jenkins, 1998; Facione, 1998; Collins, 2000). Critical thinking skills are very useful for students not only in the school but also in everyday life. Critical thinking skills can be use by students to monitoring the various opinions, based on the knowledge of the opinions that contradict it, students can assess and decide which opinions that lead to scientific truth (Zubaidah, 2015).

Prior knowledge gained through interaction with the environment, therefore, teachers should provide an environment that stimulate the activation process of students' prior knowledge can improve mental processes or the involvement of students' critical thinking skills. Arends (2004) stated that efforts to accelerate students' cognitive development is to involve and provide a suitable environment so that students independently conduct investigations to solve the problem and propose solutions, and to compare findings with the findings of others. Simas eric model is believed to accelerate the cognitive development of students which means it can improve students' critical thinking skills. Actively involving in learning model, because the model is used in the study related to the critical thinking skills of students. Gadzella (1997) found a direct relationship, a positive and significant relationship between the learning process very well prepared and critical thinking skills. Critical thinking skills are also related to student learning outcomes.

4.6 The Effect of Simas eric model Interaction with the Different Academic Level toward Students Critical Thinking Skills

Research indicates that there is interaction effect between the learning model based on academic level of the students' critical thinking skills. Students with low academic skills taught by Simas eric model had an enhancement in critical thinking skills that were higher than the high academic ability class which was taught using the conventional learning model. The results of this study can be explained that the critical thinking skills of low academic students can be empowered by using Simas eric model. Several reasons can be described as follows. 1) Simas eric encourage students to improve critical thinking skills. Simas eric through learning students will ask questions, solve problems, and collaborate with peers. Some of the students' ability honed continuously learning by Simas eric model with certainty. 2) High academic level to facilitate the ability of problem analysis, arguing, develop ideas, provide solutions, criticize, make decisions and draw conclusions based on careful consideration. Implications of the findings of this research is the application of appropriate learning models is a key factor in efforts to improve critical thinking skills of students with different academic level. Schafersman (1991) stated teachers need to help students to develop critical thinking skills through the strategies and methods of learning that encourages students to learn actively.

In Simas eric model, there are learning habit that allows the improvement of students' critical thinking are: a question, answer, discuss answers and cooperative work. Encourage students to ask questions and make inquiries is a way to actively engage students in critical thinking (Duron, 2006). Observing the activities of students in Simas eric model, it appears that students learn to apply scientific methods followed by discussion. Proulx (2004) stated that critical thinking stage consists of elements similar to the stages of the scientific method. Further stated that the application of scientific methods followed by a discussion on the results of the investigation can empower students' critical thinking. Simas eric model students conduct cooperation in small groups to understand and solve the problems and the opportunity for students to dialogue that have an impact on the improvement of critical thinking skills. According to Slavin (2009) essentially, cooperative learning is aimed to accustom social skills regarding to leadership learning, decision making, trust building, communication, and handling problems together. In cooperative working, it gives students the opportunity to discuss in open groups. According to Konberg and Griffin (2000), one way to train students to think critically is through analysis of the problem using repetition method which can help students master the complex material and be able to improve their critical thinking skills.

Conclusions

The Conclusions of this study, that: Simas eric model is able to improve students' critical thinking compared with conventional learning classes. High academic students were taught using Simas eric model had increasing critical thinking skill higher than conventional class. The increasing value of students' critical thinking skill with low academic were taught using Simas eric model is higher than the increasing value of students on high academic students which were taught using conventional model.

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