International Journal of Instruction
e-ISSN: 1308-1470 ● www.e-iji.net

April 2019 ● Vol.12, No.2
p-ISSN: 1694-609X
pp. 417-434

Received: 21/09/2018
Revision: 17/01/2019
Accepted: 25/01/2019
OnlineFirst:14/03/2019

RICOSRE: A Learning Model to Develop Critical Thinking Skills for Students with Different Academic Abilities

Susriyati Mahanal
Dr., Department of Biology Education, Universitas Negeri Malang, Indonesia

Siti Zubaidah
Prof., Department of Biology Education, Universitas Negeri Malang, Indonesia, *siti.zubaidah.fmipa@um.ac.id*

Ika Dewi Sumiati
Graduate School of Universitas Negeri Malang, Indonesia

Tri Maniarta Sari
Graduate School of Universitas Negeri Malang, Indonesia

Nur Ismirawati
Dr., Department of Biology Education, Universitas Muhammadiyah Pare-Pare, Indonesia

The purpose of this study was to investigate the effect of RICOSRE learning models towards critical thinking skills of students with different academic abilities. This quasi-experimental study employed a pretest-posttest nonequivalent control group design and involved all the eleventh-grade students from high schools in Malang, Indonesia. The sample consisted of 134 students from two separate schools which represented different academic abilities (high and low). Data were collected using an essay test on students' critical thinking skills. A rubric was employed to assess students' answers and the results were analyzed using ANCOVA. Findings suggest that (1) there is a difference between the critical thinking skills of students whose learning was facilitated with RICOSRE and critical thinking skills of students who were engaged in conventional learning, (2) there is a critical thinking difference between the high and low ability students, (3) there is a difference in students' critical thinking skills affected by the interaction between learning models and students' academic abilities. Based on the results of this study, it can be concluded that RICOSRE can close the critical thinking skills gap between the high and low ability students.

Keywords: RICOSRE, learning model, academic ability, critical thinking, teaching

Citation: Mahanal, S., Zubaidah, S., Sumiati, I. D., Sari, T. M., & Ismirawati, N. (2019). RICOSRE: A Learning Model to Develop Critical Thinking Skills for Students with Different Academic Abilities. *International Journal of Instruction*, 12(2), 417-434. https://doi.org/10.29333/iji.2019.12227a

INTRODUCTION

High-quality education equips students with higher order thinking skills (Zubaidah, Fuad, Mahanal, & Suarsini, 2017) that allow students to develop an ability to produce ideas and to solve problems in learning (Heong, Yunos, Othman, Hassan, Kiong, & Mohamad, 2012). These skills are usually embedded in a particular discipline, such as biology. One of the components of the higher order thinking is critical thinking skills (King, Goodson, & Rohani, 2010).

Critical thinking skills include analyzing, evaluating, and reconstructing information in order to make a decision and act on it (Haghparast, Nasaruddin, & Abdullah, 2013). The skills, needless to say, can help students to deal with social problems, scientific problems, and practical problems effectively. Therefore, these skills can be integrated into a learning process through exercises and simulation (Colln-Appling & Giuliano, 2017).

Critical thinking skills play a major role in students' success in learning (Halpern, Millis, Graesser, & Butler, 2012); however, research conducted within an Indonesian learning context showed students' insufficiency in mastering the skills (Kurniawati, Zubaidah, & Mahanal, 2015). Also, as a result of the implementation of incompatible and discouraging learning models, facts also prove that critical thinking skills of high school students in Malang, especially in Biology, fall into the low category (Corebima, 2016).

Academic ability is one of the determining factors of students' achievement in mastering critical thinking skills. Students with good academic ability will be more competent to construct ideas and solve problems logically (Karbalaei,2012). Academic ability is associated with intelligence effects and intelligence is an important element in the development of students' critical thinking (Karagol & Bekmezci, 2015).

High School student admission system in Indonesia is one of the reasons why there was an achievement gap between the high ability and low ability students. The admission system requires schools to use the Minimum Passing Level National Exam (MPLNE) scores as the standard to select their students which leads to a phenomenon where some particular schools are dominated by either the high or low ability students only. For example, Public High School Number 3 in Kupang, only want students who had a score of MPLNE between 27.70-36.04, while PGRI High School in Kupang can accept students with scores of MPLNE between 11.00-12.00 (Yusnaeni, Corebima, Susilo, & Zubaidah, 2017).

There has been a paradigm shift in scientific subjects learning. Some learning models have been enhanced to accommodate the development of students' higher-order thinking skills (Leou, Abder, Riordan, & Zoller, 2006), placing the teacher as the agent who is responsible to encourage students to think at the higher order levels. Yet, the facts show that science subjects learning is mostly focused on information transfer rather than empowering activities that can develop students' scientific reasoning (Mainali, 2012).

One way to promote students' critical thinking skills is through training. During the training, students should be taught how to create meaningful links among concepts in a proportional form and how to find a relationship between knowledge and practice (Novak & Canas, 2006). These activities can be accommodated by a learning model (Cantor, DeLauer, Martin, & Rogan, 2015).

Critical thinking skills can be taught explicitly. Teachers can implement a student-centered learning model to help students develop the skills (Mahanal, Zubaidah, Bahri, & Dinnuriya, 2016; Fuad, Zubaidah, Mahanal, dan Suarsini, 2017). One of the examples of the student-centered learning models is a learning model called RICOSRE (***R***eading, ***I***dentifying a problem, ***CO***nstructing the solution, ***S***olving the problem, ***R***eviewing the solution, and ***E***xtending the solution).

The main focus of RICOSRE is problem solving activities (Mahanal & Zubaidah, 2017). As pointed out by Hussain & Munshi (2011), problem-based learning emphasizes the enhancement of students' critical thinking skills rather than knowledge acquisition. An effective way to teach problem-solving strategies to students is to guide them to apply a series of problem-solving activities in details (Moreno, Reisslein, & Ozogul. 2009). As students develop problem-solving skills, their higher order thinking skills can also be promoted (Carson, 2007; Kumar & Natarajan, 2007; Snyder &Snyder, 2008). Therefore, problem-based learning is considered more promising in developing students' critical thinking skills compared to conventional learning which is merely focused on content memorization (Bachtiar, Zubaidah, Corebima, & Indriwati, 2018).

RICOSRE learning model is designed to improve students' higher-order thinking. The syntax of RICOSRE consists of reading, identifying a problem, constructing the solution, solving the problem, reviewing the solution, and extending the solution (Mahanal & Zubaidah, 2017). RICOSRE learning model has been proven effective to enhance students' critical thinking skills (Sumiati, 2017), creative thinking skills (Sari, 2017), science literacy (Rosyada, 2018), science process skills (Yuliskurniawati, 2018), and scientific argumentation skills (Noviyanti, 2018); however, RICOSRE potential to close the gap between the low and high ability students' needs to be explored.

Theoretical Background

Critical Thinking Skills

Numerous definitions of critical thinking show plenty of dimensions. Dewey equalizes critical thinking in reflective thinking and states that building reflective thinking is the core of education (Giancarlo & Facione, 2001). Critical thinking is also interpreted as activating the ability to analyze and evaluate evidence, identify questions, and construct logical conclusions. Critical thinking skills result from an intellectual process to apply, analyze, synthesize and evaluate information collected from or by active and creative observation, experiences, reflection, reasoning, and communication (Facione, 2013).

The common definition of critical thinking is conveyed by Ennis (2013) who elucidates it as a reasonable reflective activity that focuses on deciding what to believe and what to do. Critical thinking involves the activities of interpreting, analyzing, summarizing, and evaluating information. Accuracy, precision, relevance, depth, wideness, logic,

significance, and fairness are critical thinking merits. Think critically is to focus on analyzing, organizing, clarifying, developing, prioritizing, or sorting out ideas (Treffinger & Isaksen, 2013). Critical thinking can help students make careful judgment and resolve problems on a daily basis (Zubaidah, Corebima, Mahanal, & Mistianah, 2018).

Critical thinking skills are crucial for students because they take part in students' thinking development. Critical thinking skills belong to one of the basic and intellectual needs every individual has to meet (Aizikovitsh-Udi & Cheng, 2015). Critical thinking is not only able to enhance students' academic ability but also can prepare students to become a professional in the work field.

RICOSRE Learning Model

RICOSRE is a problem-based learning model developed by Mahanal & Zubaidah (2017). RICOSRE is an acronym of syntax consisting of (1) Reading (2) Identifying the problem, (3) Constructing the solution, (4) Solving the problem (5) Reviewing the solution and (6) Extending the solution. Every stage of RICOSRE facilitates students to apply higher order thinking as explained below.

The first syntax is reading. Reading is not only about expressing what is in the text but includes the process of constructing meaning (Akin, Koray, & Tavukcu, 2015; Yu-hui, Li-rong, Yue, 2010). Reading also involves coordinating affective and cognitive components such as observing, focusing, having perception, memorizing, building relationships, analyzing, and interpreting (Çer & Şahin, 2016).

The second syntax is identifying a problem. This stage constitutes the foundation of the problem solving process (Hippel & Krogh, 2015). At this stage, the problem solver, in this case, the students are required to identify an unclear and unstructured problem. The identified problem will then be formulated into questions to be solved. Formulating questions and asking questions are the indicators of critical thinking skills (Ennis, 2011).

The third syntax is constructing the solution. This phase allows students to find one or more strategies to solve the problem. Every strategy must include detailed procedures on how to solve the problem (Cheng, She, & Huang, 2018). Students who think critically admit that the critical thinking activity is an effort to provide responses to the inquiries or to construct solutions to the problem.

The fourth syntax is solving the problem by implementing the problem-solving procedures introduced at the previous stage. The problem solving strategy represents one's thinking skill (Temel, 2014). The fifth syntax is reviewing the solution where students will communicate to get feedback and to widen the information from the investigation results. The sixth syntax is extending the solution where students analyze how effective and efficient the strategy and analyze the probability to apply the solution to similar problems (Bayazith, 2013). Extending the solution is done by encouraging students to apply new knowledge and skills obtained from solving the problem to a new homogeneous phenomenon. Understanding the nature of the problem and developing skills to solve it are amount to critical thinking skills (Paul & Elder, 2007).

Academic ability

The academic ability can be defined as an achievement in knowledge and skills learned in an academic context (Kızılhan, 2011). Initial academic ability is students' knowledge that covers mastering specific contents they have learned prior to participating in a new lesson chapter (Torff, 2006). As the basis of the knowledge construction process, this knowledge helps students to integrate new knowledge (Felton & Kuhn, 2007). The initial academic ability can have a significant effect on students' upcoming academic ability, which means that the knowledge may become a strong predictor on how well students will achieve the learning objectives (Hattie, 2012). In addition, students' prior knowledge has been proven to significantly contribute to students' academic ability (Yenilmez, Sungur, & Tekkaya, 2006).

Academic ability is associated with critical thinking skills (Dehghani, Mirdoraghi, & Pakmehr, 2011). Students who possess high academic ability are better at processing information, organizing, deducting, and exploring knowledge based on experiences (King, Goodson, & Rohani, 2010). The relationship between academic ability and critical thinking skills has been shown in the previous studies. The results of the studies show that critical thinking skills of students who have the high academic ability are superior to those of students with the low academic ability (Mamu, 2014; Taghva, Rezai, Ghaderi, & Taghva, 2014).

Research Objectives

The current research aimed to identify (1) the difference between critical thinking skills of students whose learning was facilitated with RICOSRE and critical thinking skills of students who were taught with conventional learning methods, (2) the difference between high ability students' critical thinking skills and low ability students' critical thinking skills, (3) the difference in students' critical thinking skills affected by the interaction between learning models and students' academic abilities.

METHOD

Model of Research

This quasi-experimental study employed a pretest-post-test nonequivalent control group design using factorial 2 x 2 version as shown in Table 1. The independent variables of this research included learning models (RICOSRE and conventional) and academic ability (AA) while the dependent variable of this study was the students' critical thinking skills.

Table 1
Quasi-Experimental Research Design

Pretest	Group	Post-test
O_1	X_1Y_1	O_2
O_3	X_1Y_2	O_4
O_5	X_2Y_1	O_6
O_7	X_2Y_2	O_8

Notes:
$O_{1.3.5.7}$ = pretest
$O_{2.4.6}$ = post-test

X_1 = RICOSRE learning model
X_2 = conventional learning model
Y_1 = high academic ability
Y_2 = low academic ability

Research Setting

This research was conducted from August to December 2017 in high schools in Malang, Indonesia. It was carried out on two lesson topics, the Structure and Function of Plant Tissue, and the Structure and Function of Animal Tissue.

Research Population and Sample

The population of this research was all the eleventh grader from 10 (ten) high schools in Malang, Indonesia which consisted of three public high schools representing the high ability group, four public high schools representing the medium ability group, and three public high schools representing the low ability group. The selection of the school's category was done based on the Passing Level National Exam scores set by the Department of Education Malang, Indonesia. Multi-stage sampling technique was used to select the samples from two groups of students, the high ability (1 school) and the low ability (1 school). The high category was represented by 68 students from two classes of Public High School Number 4 in Malang and the low category was represented by 68 students from two classes of Public High School Number 10 in Malang. The total number of research participants was 136 students who were divided into two experimental classes and two control classes.

The experimental classes were taught by the researchers using RICOSRE, while the control classes were taught by the school's Biology teachers using conventional methods. Students in the RICOSRE classes were equipped with the worksheet. The worksheet contained two learning activities. Learning activity 1 discussed the structure and function of each of the plant tissues, while learning activity 2 discussed the structure and function of each of the animal tissues. The learning stages contained in the worksheet were adjusted to the RICOSRE learning syntax. There were texts provided on the worksheet. The students were required to read the texts before proceeding to the next stage of learning that was to identify a problem. After identifying the problem, the students needed to formulate it in the form of questions and predict the answer. Then, the students were required to construct a solution to the problem, choose an appropriate strategy to solve the problem by making hypotheses, simplify the problem, and make assumptions based on knowledge obtained from the previous stage. After that, the students had to implement the problem solving strategy and write the results on the worksheet. The results of the collaborative work were then communicated with other groups. Feedback and suggestions were welcomed at this stage. The last stage of RICOSRE was to allow the students to evaluate the effectiveness of the problem solving strategy and to probably find an alternative solution which is more effective than the previous or to make problem generalization which can help them to solve similar problems in the future. In RICOSRE, the students played a more significant role in learning compared to the teacher. The teacher, in this case, served as an active facilitator

in the classroom. S/he had to guide or provide scaffolding for the students when necessary. Unlike RICOSRE, the conventional methods did not follow certain learning syntax. On the other hand, conventional methods mainly included information transfer (lecturing), group discussion, and task assignment. The implementation of RICOSRE and conventional methods in this study used the same duration and the same basic competencies.

Instrument and Data Analysis

The student's critical thinking skills were measured using the essay test. The essay test was selected as the instrument because it was considered the most suitable test to be applied in Indonesia (Zubaidah, Corebima, & Mistianah, 2015). The question contained 8 essays included the topics of the structures and functions of the plant and animal tissues. Here are two examples of the essay test items.

1. Gresik city has low air humidity and deep groundwater sources. The government plans to build some green spaces with an "evergreen" concept and plant pine trees in the areas. Make a logical statement about the effectiveness of the evergreen pine-green spaces!
2. Liposuction is a surgical technique wherein the doctor draws a certain amount of fat from several parts of the patient's body. This technique is useful for removing fat deposits in certain parts that are stored in the form of fat drops or droplets. The body weight of people who have undergone liposuction tends to rise quickly because new fat cells will be placed on other parts of the body. Based on the statement, analyze the relationship between the impact of liposuction and the body's tissue structure!

The students' answers were evaluated using a rubric developed by Zubaidah et al. (2015). This rubric measured two categories: student's critical thinking which is not apparent or not well developed (score 1-2) and starts to developed or well developed (3-5). The instrument test had been validated and satisfied the standard of a reliable test. The validity test was performed using the product moment correlation with sig level 0.0001-0.013 < a (a = 0.05). Cronbach's Alpha statistics showed that instruments were reliable with $r = 0.689$. The validity and reliability can be seen in Table 2.

Table 2
The Results of the Validity and Reliability Tests

Number	Pearson Correlation	Sig. Level	Validity
1	0.595	0.006	Valid
2	0.505	0.004	Valid
3	0.565	0.003	Valid
4	0.626	0.001	Valid
5	0.600	0.005	Valid
6	0.560	0.013	Valid
7	0.677	0.008	Valid
8	0.494	0.011	Valid

Data Collection and Data Analysis

The research data were analyzed using covariance analysis (ANCOVA), normality test, and sample homogeneity test. These data were collected to test the hypotheses which were formulated as follows: (1) There was a difference in students' critical thinking skills after receiving different treatments of learning models (2) There was a difference in students' critical thinking skills in regards to different academic abilities (3) There was a difference in students' critical thinking skills in regards to the interaction between learning model and academic abilities.

The analysis of covariance (ANCOVA) was begun by performing a normality test using One-Sample Kolmogorov-Smirnov Test. The homogeneity test used the Leven's Test of Equality of Error Variances. The normality test conducted on the students' critical thinking skills resulted in *p-value* 0.200, *p-value* > α (α = 0.05) which suggested that the data was distributed normally. The result of the homogeneity test showed *p-value* 0.872, *p-value* > α (α = 0.05) which implied that the students' critical thinking skills were homogeneous.

FINDINGS

The results of the ANCOVA analysis were presented in Table 3 and Table 4. The result of the ANCOVA test alone was summarized in Table 3. Table 3 indicated that H_0 shall be rejected and hence the alternative hypothesis which suggested that there was a difference in students' critical thinking skills after they were exposed to two different learning models was accepted with $F(x1,x2) = 23.448$ and a significance level of $0.00 < 0.05$). In addition, with $F(x1,x2) = 24.727$ and a significance level of $0.00 < 0.05$, the table implied that there was a difference between high ability students' critical thinking skills and low ability students' critical thinking skills. In other words, H_0 was rejected and H1 was accepted. The table also showed that there was a difference in students' thinking skills as the result of the interaction between the learning models and academic abilities with $F(x1,x2) = 6.937$, sig. $0.002 < 0.005$).

Table 3
The Results of the ANCOVA Analysis

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Intercept	23157.815	1	23157.815	257.725	.000
Pre-Critical	352.746	1	352.746	3.926	.050
AA	2221.794	1	2221.794	24.727	.000
Model	2106.921	1	2106.921	23.448	.000
AA * Model	623.284	1	623.284	6.937	.002
Error	11770.960	131	89.855		
Total	838800.000	136			
Total Score	18225.765	135			

Note:
Pre-Critical: pretest of critical thinking skills
AA = Academic Ability

Based on the results, the Least Significance Difference (LSD) test could be conducted. Findings of the test were depicted in Table 4. Table 4 suggested that there was a clear-cut difference between the combined groups. The RICOSRE-AA low group result was different from that of the Conventional-AA low group. However, the RICOSRE-AA high and the RICOSRE-AA low group did not show any significant difference, neither did the conventional-AA high group and RICOSRE-AA low group. The Conventional-AA high group was reported to be significantly different from the Conventional-AA low group. Given the information presented in Table 3, the Conventional-AA low group achieved the lowest total score (66.41) while the highest score (87.36) was obtained by the RICOSRE-AA high group. The Conventional-AA high group was reported to achieve better (80.41) than the RICOSRE-AA low (78.86). The highest score increase (from the pretest to posttest) was observed in the RICOSRE-AA high group (14.76 or 20.06%), followed by the RICOSRE-AA low group (11.68 or 17.11%), the Conventional-AA high group (9.85 or 13.99%), and the Conventional-AA low group (5.52 or 0.8%). The results suggested that RICOSRE learning model was able to improve the low ability students' critical thinking skills to the point equal to what the high ability can attain in the conventional group.

Table 4
The Result of the Least Significance Difference (LSD) Test

Model	AA	GROUP	PRE-TES	POS-TES	INCREASE	CRITICAL-COR	LSD Notation
Conventional	Low	1	62.36	67.88	5.52	66.41	a
RICOSRE	Low	3	68.26	79.94	11.68	78.86	b
Conventional	High	2	70.36	80.21	9.85	80.41	b
RICOSRE	High	4	72.76	87.36	14.76	87.36	c

Note:
AA = Academic Ability

In summary, according to Table 3 and Table 4, it can be concluded that: (1) The null hypothesis that stated learning models had no effect on students' critical thinking skills was rejected and hence the research hypothesis was accepted because the results of this study suggested that learning models had an effect on the students' critical thinking skills (Shim & Walczak, 2012); (2) The null hypothesis that stated that there was no difference found between the high and low ability students' critical thinking was rejected and hence the research hypothesis was accepted. There are no errors in this hypothesis because the results of the study are in accordance with the theory which suggests that academic abilities influence students' critical thinking skills. Students with high academic abilities have better initial knowledge than students with low academic abilities. Therefore, the thinking skills of the high ability students can improve more significantly faster than those of the low ability students (Ausubel, 1998). (3) The null hypothesis which stated that there was no interaction effect of the learning model with students' academic ability shall be rejected and hence the research hypothesis shall be accepted. No consistent results were found in the interaction between learning models

and academic abilities and its impact on students' higher-order thinking such as critical and creative thinking.

DISCUSSION

Learning Models and Students' Critical Thinking Skills

The results of the current research have proven that there is a difference found in the students' critical thinking skills after their learning was accommodated by RICOSRE. Compared to the students who used conventional learning, the RICOSRE group of students was reported to score significantly better at the critical thinking skills test. There are many studies that mention the benefits of implementing RICOSRE in promoting students' critical thinking skills. One of which is that RICOSRE learning model facilitates students' active involvement in the learning process (Mahanal, et al. 2017). By applying the learning model, students are encouraged to think actively (Mulnix, 2012) and as a result, be passionately engaged in discussion and evaluation activities. The students' active participation in learning may result in their increased ability to make decisions, predict assessment, and solve problems (Burbach, Matkin, & Fritz, 2004).

The contribution of RICOSRE learning model lays on its syntax which consists of reading, identifying a problem, constructing the solution, solving the problem, reviewing the solution, and extending the solution. Improving students' critical thinking skills is supported by an increase in reading activities. Reading has a strategic position in empowering students' thinking skills (Zubaidah, 2014). Reading activities are directly connected with critical activities because reading often requires critical, analytical, and expressive abilities, as well as self-discovery (Wang, 2012). Furthermore, according to Aljaberi (2015) understanding problems can lead students to the process of critical thinking. This stage contains activities to identify available information and data, assumptions, and expected results. Making questions and predicting answers also contribute to improving students' critical thinking skills. Critical students will make critical questions. Questions are a tool that can be used to improve students' thinking skills (Lubliner, 2004). In the next stage, that is to construct the solution, students can access, analyze, and synthesize relevant information to explore the problem. Constructing a solution is seen as a cognitive process that has implications for students' literacy development in higher order thinking (Naderi, et al., 2010).

Problem solving activities can be used by teachers to teach students how to think. Students' thinking skills can be developed through problem-based learning and the improvement of students' critical thinking skills, creative thinking skills, decisions making ability, conceptions formation, and information processing (Carson, 2007). The final stage in the face-to-face learning was reviewing and extending the solution. At this stage, the students were guided to conduct class discussions and reflect on suggestions given by other students from other groups. Also, the students were required to have the ability to choose the right concepts to be accepted as suggestions. These skills provide a good impact on students' critical thinking skills (Hussain & Munshi, 2011).

Academic Abilities and Students' Critical Thinking Skills

The results of the hypothesis testing presented in Table 2 show that there is a difference between high ability students' critical thinking skills and low ability students' critical thinking skills. Some studies have underlined the effect of different academic abilities on students' critical thinking skills (Taghva et al., 2014; Mahanal, Tendrita, Ramadhan, Ismirawati, & Zubaidah, 2017). Due to their preexisting knowledge, students with high academic ability are believed to perform better in solving complex problems which require a higher order of thinking that students with low academic ability. Prior knowledge helps students to access, organize information, and create a new connection of information, as well as identify relevant and accurate information. Therefore, students with higher academic ability will have superior critical thinking skills compared to students with lower academic ability.

Initial academic ability contributes to students' academic ability in the upcoming learning process (Dehghani et al, 2011. Vygotsky emphasizes the importance of past experience, prior knowledge, social interaction, and culture in promoting the cognitive development of an individual (Karbalaei, 2014). The effect of the prior knowledge on students' learning achievement is significant because most of the learning theories and instructional model designs consider prior knowledge as the key element in the learning process.

Critical thinking skills are strongly associated with students' academic ability (Kanbay, Isik, Aslan, Tektas, & Kilic, 2017). Students' academic ability may vary across grades. Thus, the students' academic ability must be taken into account in designing a lesson. The anticipated result of careful consideration is the minimized achievement gap between different groups of students and the improvement in students' academic ability.

The Effect of the Interaction between Learning Models and Students' Academic Ability on Students' Critical Thinking Skills

The results of the LSD test (Table 3) indicate that there are no significant differences found between the RICOSRE-AA low group and Conventional-AA high group, while the highest score is achieved by the RICOSRE-AA high group. Given this information, it can be concluded that the RICOSRE-AA high is the most effective combination of empowering and supporting students' critical thinking skills. The reasons are: 1) RICOSRE learning model encourages students to improve their critical thinking skills. RICOSRE habituate students to explore various problems, identify problems, find the solution, implement detailed problem solving stages, and collaborate with the same-age peers. 2) high academic ability facilitates students to develop their skills in solving problems, stating arguments, developing ideas, giving solutions, criticizing, making decisions, and making an inference based on careful reasoning.

Table 3 also suggests that the implementation of a learning model that can suit learners' needs such as RICOSRE can minimize the gap between the high and low ability students (Tavakolizadeha, Tabarib, & Akbari, 2015). Students' academic ability is affected by learning experiences which can be obtained through the implementation of an appropriate learning model (Hsieh & Dwyer, 2009). Appropriate learning models that can accommodate students' academic and critical thinking skills include the problem-based learning models (Halvorsen et al, 2012), cooperative integrated inquiry learning

model (Prayitno, Corebima, Susilo, Zubaidah, & Ramli, 2017), and integrated Solve-Create-and-Share and metacognitive strategy learning model (Yusnaeni, Corebima, Susilo, Zubaidah, 2017).

Critical thinking skills can be taught explicitly at school. Thus, teachers play a major role in encouraging students to be actively engaged in learning (Mulnix, 2012). In addition, Radulovi and Stančić (2017) also point out that schools should consider academic subjects as the foundation to build students' critical thinking skills and to prepare them to be successful in their life.

The results of the research displayed in Table 2 and Table 3 show a critical thinking increase in all combination groups, including the conventional-high, conventional-low, RICOSRE-high, and RICOSRE-low. Students' critical thinking skills can be improved through learning models applied by the teacher (Crowe, Dirks, & Wenderoth, 2008). The critical thinking improvement of the high ability groups was higher than that of the low ability group despite different learning models implemented in the classrooms (conventional methods and RICOSRE). This finding indicates that the students' academic abilities can influence their critical thinking skills (Dehghani, Mirdoraghi, & Pakmehr, 2011).

Students with high academic abilities have better abilities in responding and understanding lessons compared to students with low academic ability. With the skills and abilities they possess, the high ability students are able to understand the lesson better, and thus their critical thinking skills are significantly higher than those of the low ability students. Students who are facilitated with RICOSRE learning have higher critical thinking skills than students who are facilitated with conventional learning. RICOSRE helps students to be actively involved in learning. Student-centered learning is one of the means that can be used to promote students' critical thinking skills (Sayre, 2013).

CONCLUSION

The results of the present research suggest that:

1. There is a difference between the critical thinking skills of students whose learning was facilitated with RICOSRE and critical thinking skills of students who were engaged in conventional learning.

2. There is a difference between high ability students' critical thinking skills and low ability students' critical thinking skills.

3. There is a difference in students' critical thinking skills affected by the interaction between learning models and students' academic abilities. and discussion, it can be concluded as follows. The LSD test indicates that there is no significant difference between the Conventional-AA high group and the RICOSRE-AA low group. So based on the research result, it is clear that RICOSRE learning model can lower the critical thinking skills gap between students with high and low academic ability.

This research was conducted in a limited Biology learning context which is the high school level. Therefore, it is recommended for future researchers to explore different subjects at different levels of education, such as the elementary or university level. It is

also advisable that future research can be focused more on other higher-order thinking skills such as creative thinking skills, problem solving skills, and metacognition.

REFERENCES

Aizikovitsh-Udi, E., Cheng, D. (2015). Developing critical thinking skills from dispositions to abilities: mathematics education from early childhood to high school. *Creative Education*, 6, 455-462.

Akın, F., Koray, O., Tavukçu, K. (2015). How effective is critical reading in the understanding of scientific texts? *Procedia - Social and Behavioral Sciences*, 174, 2444 – 2451.

Aljaberi, R. (2015). Creative and its relation to academic achievement and teaching performance of pre-service female teachers in Ajman University in UAE. *Procedia - Social and Behavioral Sciences*, 174, 560 – 567.

Anne, & Kreitzberg, C. (2010). *Critical thinking for the twenty-first century: what it is and why it matters to you.* Copyright ©2010 by Anne and Charlie, LLC. All Rights Reserved. Retrieved 08 September 2018 from www.agilecriticalthinking.com.

Ausubel, D. P. (1998). Ausubel's Learning Theory: An Approach to Teaching Higher Order Thinking Skills. *High School Journal.* 82(1): 35-42.

Bachtiar, S., Zubaidah, S., Corebima, A.D., Indriwati, S.E. (2018). The spiritual and social attitudes of students towards integrated problem-based learning models. *Issues in Educational Research*. 28(2), pp. 254-270.

Bayazith, I. (2013). An investigation of *problem solving* approaches, strategies, and models used by the 7th and 8th-grade students when solving real-world problems. *Educational Sciences: Theory & Practice*.

Burbach, M. E., Matkin, G. S., & Fritz, S. M. (2004). Teaching critical thinking in an introductory leadership course utilizing active-learning strategies: A confirmatory study. *College Student Journal*, 38/3, 482-493.

Cantor, A., DeLauer, V., Martin, D., & Rogan, J. (2015). Training interdisciplinary "wicked problem" solvers: Applying lessons from HERO in community-based research experiences for undergraduates. *Journal of Geography in Higher Education*, 39, 407–419.

Carson, J. (2007). A Problem with problem solving: teaching thinking without teaching knowledge. *The Mathematics Educator*, 17(2), 7–14.

Cheng, S-C., She, H-C., Huang, L-Y. (2018). The impact of problem-solving instruction on middle school students' physical science learning: interplays of knowledge, reasoning, and problem solving. *EURASIA Journal of Mathematics, Science and Technology Education* ISSN: 1305-8223 (online) 1305-8215 (print) 2018, 14/3, 731-743.

Colln-Appling, C.V & Giuliano, D. (2017). A concept analysis of critical thinking: A guide for nurse educators. *Nurse Education Today*, 49, 106–109.

Corebima, A.D. (2016). Pembelajaran biologi di Indonesia bukan untuk hidup [Biology learning in Indonesia is not for life]. *Proceeding Biology Education Conference* (ISSN: 2528-5742). 13(1), 8-22.

Crowe, A., Dirks, C., & Wenderoth, M. P. (2008). Biology in bloom: Implementing bloom's taxonomy to enhance student learning in biology. *CBE Life Sci. Educ*, 7, 368–381.

Dehghani, M., Mirdoraghi, F., & Pakmehr, H. (2011). The role of graduate students' achievement goals in their critical thinking disposition. *Procedia Social and Behavioral Sciences*, 15, 2426–2430.

Ennis, R. E. (2011). *The nature of critical thinking: an outline of critical thinking dispositions and abilities.* International Conference on Thinking at MIT, Cambridge. Retrieved from: http://faculty.ed.uiuc.edu/rhennis.

Ennis, Robert H. (2013). "*Critical thinking across the curriculum (CTAC)*". OSSA Conference Archive. 44. Retrieved September 9, 2016, from https://scholar.uwindsor.ca /ossaarchive/OSSA10/papersandcommentaries/44

Facione, P. A. (2013). *Critical thinking: what it is and why it counts*. Retrieved September 15, 2016, from http://spu.edu/depts/health-sciences/grad/documents/ CTbyFacione.pdf.

Felton, M.K., & Kuhn. D. (2007). "How do I know?" the epistemological roots of critical thinking. *The Journal of Museum Education*, 32(2), 101-110

Fuad, N. M., Zubaidah, S., Mahanal, S., and Suarsini, E. (2017). Improving junior high schools' critical thinking skills based on test three different models of learning. *International Journal of Instruction*. 10(1), 101-116.

Giancarlo, C.A., Facione, P.A., (2001). A look across four years at the disposition toward critical thinking among undergraduate students. Journal of General Education 50/1, 29-55.

Haghparast, M., Nasaruddin, F. H., & Abdullah, N. (2014). cultivating critical thinking through e-learning environment and tools: a review. *Procedia-Social and Behavioral Sciences*, 129, 527–535.

Halpern, D, F., Millis, K., Graesser, A.C., & Butler, H. (2012). Operation ARA: a computerized learning game that teaches critical thinking and scientific reasoning. *Thinking Skills and Creativity*, 7, 93-100.

Halvorsen, A-L., Duke, N.K., Brugar, K.A., Block, M.K., Strachan, S.L., Berka, M.B., & Brown, J. M. (2012). Narrowing the achievement gap in second-grade social studies and content area literacy: the promise of a project-based approach. *Theory & Research in Social Education*. 40(3, 198-229.

Hattie. J. (2013). Visible learning for teachers: maximizing impact on learning. the main idea current education book summaries. Retrieved 27 August 2018 from https://www.egfl.org.uk/sites/default/files/SUMMARY%20OF%20VISIBLE%20 LEARNING.pdf

Hippel, E von., & Krogh, Georg von. (2015). Identifying viable "need–solution pairs": problem solving without problem formulation. *Organization Science*. 27(1), 207–221. ISSN 1047-7039 (print) ISSN 1526-5455.

Heong, Y.M., Yunos, J.M., Othman, W., Hassan, R., Kiong, T.T., & Mohamad, M.M. (2012). the needs analysis of learning higher order thinking skills for generating ideas. *Procedia-Social and Behavioral Sciences*, 59: 197-203.

Hsieh, P. H., & Dwyer, F. (2009). The instructional effect of online reading strategies and learning styles on student academic ability. *Educational Technology & Society*, 12(2), 36–50.

Hussain, I. & Munshi, P. (2011). Identifying reading preferences of secondary school students. *Creative Education*, 2(5), 429-434.

Karbalaei, A. (2012). Critical thinking and academic achievement. *Íkala, Revista de Lenguaje y Cultura*, 17(2), 121-128.

Karagöl, I., & Bekmezci, S. (2015). Investigating academic abilities and critical thinking dispositions of teacher candidates. *Journal of Education and Training Studies,* 3 (4). DOI: https://doi.org/10.11114/jets.v3i4.834

King, F.J., Goodson, L., M.S. & Rohani, F. (2010). Higher order thinking skills. *Assessment & Evaluation Educational Service Program*. Retrieved from https://www.cala.fsu.edu/files/higher_order_thinking_skills.pdf

Kızılhan, P. (2011). *The analyses for the effect of classroom climate on the students of primary teaching* (Unpublish doctoral dissertation). Ankara University, Institute of Educational Sciences, Ankara.

Kumar, M., & Natarajan, U. (2007). A problem-based learning model: Showcasing an educational paradigm shift. *Curriculum Journal,* 18(1), 89–102.

Kurniawati, Z. L., Zubaidah, S., & Mahanal, S. (2015). *Keterampilan berpikir kritis siswa SMA Negeri Kota Batu pada matapelajaran biologi* [*Critical thinking skills of students of Batu city high school in biology subjects*]. Paper Presented in the 2nd National Seminar and Biology and Learning National Workshop]. Department of Biology FMIPA UM. Malang, 16-17 Oktober 2015.

Leou, M., Abder, P., Riordan, M., & Zoller, U. (2006). 'Using HOCS-centered learning' as a pathway to promote science teachers' metacognitive development. *Research in Science Education*, 36(1–2), 69–84.

Lubliner, S. (2004). Help for struggling upper-grade elementary readers. *The Reading Teacher*, 57(5), 430-438. Retrieved December 12, 2018, from ERIC EBSCO database

Mahanal, S., Tendrita, M., Ramadhan, F., Ismirawati, N., & Zubaidah, S. (2017). The analysis of students' critical thinking skills on biology subject. *Anatolian Journal of Instruction*, 21-39.

Mahanal, S., Zubaidah, S., Bahri, A., & Dinnuriya, M. (2016). Improving student's critical thinking skills trough Remap NHT in biology classroom. *Asia Pacific Forum on Science Learning and Teaching,* 17(2), 1-19.

Mahanal, S & Zubaidah, S. (2017). Model pembelajaran RICOSRE yang berpotensi memberdayakan keterampilan berpikir kreatif [RICOSRE learning model that has the potential to empower creative thinking skills]. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 2(5), 676-685.

Mainali, B.P. 2012. Higher order thinking. *In Education. Academic Voices A Multidisciplinary Journal*, 2(1), 5-10.

Mamu, H. D. (2014). Pengaruh strategi pembelajaran, kemampuan akademik & interaksinya terhadap keterampilan berpikir kritis & hasil belajar kognitif IPA biologi [The influence of learning strategies, academic abilities & their interactions on critical thinking skills & cognitive learning outcomes of biology science]. *Jurnal Pendidikan Sains*, 2(1), 1-11.

Moreno, R., Reisslein, M., & Ozogul. G. (2009). Optimizing worked-example instruction in electrical engineering: the role of fading and feedback during problem-solving practice,.*Journal of Engineering Education*, 98(1), 83-92.

Mukti, W. R. (2018). *Pengaruh Model Pembelajaran RICOSRE dengan Gender Berbeda terhadap Literasi Sains dan Hasil Belajar Biologi di SMA Negeri Kota Malang* [*The Effect of RICOSRE's Learning Model with Different Gender on Science Literacy and Biological Learning Outcomes in Malang City Public High School*] (Unpublish master's thesis). Malang, Postgraduate Universitas Negeri Malang.

Mulnix, J. W. (2012). Thinking critically about critical thinking. Educational Philosophy and Theory, 44, 464–479.

Naderi, H., Abdullah, R., Aizan, H. T., Sharir, J., & Kumar, V. (2010). Relationship between creativity and academic achievement: a study of gender differences. *Journal of American Science*, 6(1), 181-190.

Norris, S.P., & Phillips, L.M. (1987). Explanations of reading comprehension: schema theory and critical thinking theory. *Teachers College Record*, 2, 281–306.

Novak, J. D., & Cañas, A. J. (2006). The theory underlying concept maps and how to construct them (Tech. Rep. IHMC CmapTools 2006-01). Pensacola, FL: Florida Institute for Human and Machine Cognition. Retrieved June 12, 2009, from http://cmap.ihmc.us/Publications/ResearchPapers/TheoryUnderlying Concept Maps.pdf

Noviyanti, N. I. (2018). *Pengaruh Model Pembelajaran RICOSRE terhadap Keterampilan Argumentasi Ilmiah dan Hasil Belajar Biologi pada Siswa Kelas X SMA Negeri Di Malang dengan Kemampuan Akademik Berbeda* [*The Influence of RICOSRE Learning Model on Scientific Argumentation Skills and Biological Learning Outcomes in X-Class Students of State High Schools in Malang with Different Academic Capabilities]* (Unpublish master's thesis). Malang, Postgraduate Universitas Negeri Malang.

Prayitno, B, A., Corebima, A.D. Susilo, H., Zubaidah, S., Ramli, M. (2017). Closing the science process skills gap between students with high and low-level academic ability. *Journal Of Baltic Science Education*, 16(2), 266-277.

Paul, R. & Elder, L. (2006). The Miniature Guide to Critical Thinking Concepts and Tools. *The Foundation for Critical Thinking* Fourth Edition. Retrieved from https://www.criticalthinking.org/files/Concepts_Tools.pdf

Radulovi, L. and Stančić, M. (2017). What is needed to develop critical thinking in schools? *CEPS Journal*, 7, 3, 9-25

Sari, T. M. (2017). *Pengaruh Model Pembelajaran RICOSRE dan Gender Terhadap Keterampilan Berpikir Kritis, Keterampilan Memecahkan Masalah Dan Hasil Belajar Kognitif Siswa Kelas XI Di SMAN Di Kota Malang* [*The Influence of RICOSRE Learning Models and Gender on Critical Thinking Skills, Skills in Solving Cognitive Problems and Learning Outcomes of Grade XI Students in Senior High Schools in Malang City*] (Unpublish master's thesis). Malang, Postgraduate Universitas Negeri Malang.

Sayre, E. (2013). *Integrating Student-Centered Learning to Promote Critical Thinking in High School Social Studies Classrooms.* A thesis in partial fulfillment of the requirements. Florida: University of Central Florida.

Shim, W-J., Walczak, K. (2012). The Impact of faculty teaching practices on the development of students' critical thinking skills. *International Journal of Teaching and Learning in Higher Education*, 24(1), 16-30

Snyder, L.G. & Snyder, M.J. (2008). Teaching critical thinking and problem solving skills. *The Delta Pi Epsilon Journal.* 5(2), 91-99.

Sumiati, I. D. (2017). *Pengaruh Model Pembelajaran Ricosre Dan Kemampuan Akademik Berbeda Terhadap Keterampilan Berpikir Kreatif, Keterampilan Berpikir Kritis, Dan Hasil Belajar Kognitif Siswa Kelas XI SMAN Kota Malang* [*The Influence of Ricosre Learning Model and Academic Ability Different to Creative Thinking Skills, Critical Thinking Skills, and Cognitive Learning Outcomes of Class XI Students of Malang State High School*] (Unpublish master's thesis). Malang, Postgraduate Universitas Negeri Malang.

Taghva, F., Rezai, N., Ghaderi, J. & Taghva, R. (2014). Studying the relationship between critical thinking skills and students' educational achievement (eghlid universities as case study). *International Letters of Social and Humanistic Sciences,* 25, 18-25.

Tavakolizadeha, J., Tabarib, J., & Akbari, A. (2015). Academic self-efficacy: predictive role of attachment styles and creative skills. *Procedia - Social and Behavioral Sciences*, 171, 113 – 120.

Temel, S. (2014). The effects of problem-based learning on pre-service teachers' critical thinking dispositions and perceptions of problem-solving ability. *South African Journal of Education*, 34 (1), 1-20.

Torff, B. (2006). Expert teachers' beliefs about use of critical-thinking activities with highland low-advantage learners. *Teacher Education Quarterly, Spring 2006. Pp. 37-52. Retrieved from* https://files.eric.ed.gov/fulltext/EJ795205.pdf

Treffinger, D. J. & Isaksen, S. G. (2013). Teaching and applying creative problem solving: implications for at-risk students. *International Journal for Talent Development and Creativity*. 1(1), 87-97.

Wang, A. Y. (2012). Exploring the relationship of creative thinking to reading and writing. *Thinking Skills and Creativity,* 7, 38-47.

Yenilmez, A., Sungur, S. and Tekkaya, C. (2006). Students' achievement in relation to reasoning ability, prior knowledge, and gender. *Research in Science & Technological Education*, 24(1), 129–138.

Yu-hui, L., Li-rong, Z., Yue, N., (2010). Application of schema theory in teaching college English reading. *Canadian Social Science*, 6(1), 59–65.

Yuliskurniawati, I. D. (2018). *Pengaruh Model Pembelajaran RICOSRE berdasarkan Gender terhadap Keterampilan Proses Sains, dan Hasil Belajar Kognitif Biologi SMA Negeri di Malang* [*The Effect of Gender-Based RICOSRE Learning Model on Science Process Skills, and Biological Cognitive Learning Outcomes of State High Schools in Malang*] (Unpublish master's thesis). Malang, Postgraduate Universitas Negeri Malang.

Yusnaeni, Corebima, A. D., Susilo, H. & Zubaidah, S. (2017). Creative thinking of low academic student undergoing search solve create and share learning integrated with metacognitive strategy. *International Journal of Instruction*, 10(2), 245-262. https://doi.org/10.12973/iji.2017.10216a.

Zubaidah, S. (2014). *Pemberdayaaan Keterampilan Penemuan dalam Scientific Approach Melalui Pembelajaran Berbasis reading concept-map cooperative learning* [*Empowerment of discovery skills in the scientific approach through reading concept-map cooperative learning concepts*]. Paper presented at the Eleventh National Seminar themed Biology, Science, Environment & Learning. Surakarta: Universitas Sebelas Maret

Zubaidah, S., Fuad, N. M., Mahanal, S., & Suarsini, E. (2017). Improving Creative Thinking Skills of Students through Differentiated Science Inquiry Integrated with Mind Map. *Journal of Turkish Science Education,* 14(4), 77-91.

Zubaidah, S., A.D. Corebima., & Mistianah. (2015). *Asesmen berpikir kritis terintegrasi tes essay*. Proceedings of Symposium on Biology Education (Universitas Ahmad Dahlan Jogjakarta, April 4, 2015), 200-213.

Zubaidah, S., Corebima, A. D., Mahanal, S., & Mistianah. (2018). Revealing the relationship between reading interest and critical thinking skills through remap gi and remap jigsaw**.** *International Journal of Instruction,* 11(2), 41-56.