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The Potential of RICOSRE in Improving Scientific Reasoning of Students with Different Academic Ability

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Abstract: The research aims to analyze the potential of the RICOSRE learning model in improving students' scientific reasoning abilities on different academic abilities. This research is a quasi-experimental research. SMAN 1 Malang and SMAN 7 Malang became a place of research with a sample of 188 students. The research design is Noneqivalent pretest - posttest control desaign group. Research data in the form of the acquisition of essay test scores. Essay test results were analyzed using anacova. Based on the research result it is proved that there is a potential of the RICOSRE on students' scientific reasoning abilities on different academic abilities.

Key Words: RICOSRE learning model; academic ability; scientific reasoning

Abstrak: Penelitian bertujuan untuk menganalisis potensi model pembelajaran RICOSRE dalam meningkatkan kemampuan penalaran ilmiah siswa dengan kemampuan akademik berbeda. Penelitian ini merupakan penelitian quasi-eksperimien. SMAN 1 Malang dan SMAN 7 Malang menjadi tempat penelitian dengan jumlah 188 siswa sebagai sampel. Data penelitian berupa perolehan skor tes esai. Hasil tes esai dianalisis menggunakan anakova. Berdasarkan hasil penelitian diketahui adanya potensi model pembelajaran RICOSRE terhadap kemampuan penalaran ilmiah siswa pada kemampuan akademik berbeda.

Kata kunci: model pembelajaran RICOSRE; kemampuan akademik; penalaran ilmiah

INTRODUCTION

The implementation of education in the 21st century is directed at developing students' abilities to carry out cognitive processes and through higher-order thinking skills, such as analyzing, synthesising and evaluating (Osborne, 2013; Hill, 2007). 21st century skills need to be developed in science learning which has a lot to do with nature and the student environment (Bybee, 2010). 21st century skills that are important to develop in learning include scientific reasoning skills (Hilton, 2008).

Scientific reasoning is an individual flow in thinking to reach a conclusion thus it can be used as a concept and knowledge based on the results of the observation process that has been passed (Khan & Ullah, 2010). The indicators used to measure this ability are *Argument or topic selection, existing Knowledge, Research, and/or Views, Methodology, Analysis, and Conclusions, Limitations and Implications* (AACU, 2010). A student who is able to reason scientifically has three cognitive components, namely the ability to make hypotheses, experiment, and evidence evaluation (Khan & Ullah, 2010). Through this ability, students can relate the cause and effect of something that happened (Kuhn, Ramsey, & Arvidsson, 2015). Scientific reasoning is an essential fundamental of science and technology education (OECD, 2017). The increasing development of science education has made scientific reasoning an important factor from an international and economic perspective (Gopnik, 2012).

In fact, students' scientific reasoning is still low. The results of research conducted by Prastiwi, Parno, and Wisodo (2018) at SMAN 7 Malang revealed that students' scientific reasoning in science learning was still low. This makes it difficult for them to solve problems in the learning process (Khan & Ullah, 2010). Science learning in schools is still dominated by low-level cognitive demands, especially memory (Osborne, 2013). It was causes by the use of learning models that do not develop students' scientific reasoning abilities, as well as the lack of opportunities for students to find and build their own knowledge. In addition, students do not have the opportunity to practice solving problems (Zimmerman, 2005).

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Students 'scientific reasoning abilities are also influenced by students' academic abilities related to the IQ of each student (Khoirina, Cari, & Sukarmin, 2018) (Veas & Gilar, 2016). Initial knowledge is one of the factors that can determine a person's achievement (Hailikari, Katajavuori, & Lindblom-Ylanne, 2008). Academic ability affects students' ability to think critically (Mahanal, Zubaidah, Sumiati, Sari, & Ismirawati, 2019). Therefore, the research aims at examining whether it also affects students' scientific reasoning.

Teachers have not paid attention to different academic abilities during the learning process. The learning strategies that have been used by teachers have not fully paid attention to the various academic abilities of students (Corebima, 2007). Teachers should apply a learning model that takes into account students' differences in academic abilities, so that scientific reasoning can be developed at all levels of academic ability. Problem-based learning is a solution to improve students' scientific reasoning skills (Malahayati, 2011). Guided inquiry and RICOSRE are problem-based learning that can practice scientific reasoning skills. The syntax in RICOSRE is complemented by grouping students into heterogeneous groups. This grouping can reduce the gap between low and high academic ability.

RICOSRE is a model that can develop creative and critical thinking skills, solve a problem that can familiarize students with complex thinking (Sari, Mahanal, & Zubaidah, 2018). Based on this view, the researchers conducted research aimed at analyzing the potential of the RICOSRE learning model in improving scientific reasoning of students with different academic abilities.

METHOD

This research was a quasi-experimental. RICOSRE's learning model and students' academic abilities served as independent variables and scientific reasoning served as a dependent variable. A number of 188 students of X grade at SMAN 1 Malang and SMAN 7 Malang were randomly selected as research samples. Students were grouped into high and low Academic Ability Groups. The National Exam scores were used as the basis for grouping students into different academic groups. The research was conducted during the odd semester of the 2019/2020 academic year. Data collected through *pretest* and *posttest* using validated essay questions. Before testing the research hypothesis, the homogeneity and normality prerequisite test were conducted. Hypothesis testing was done by ancova test, then continued with the LSD test to determine the significance or significant difference.

RESULTS

Pre-requisite Testing

The results of the normality test on research data were in the form of normality significance values for scientific reasoning skills data. The analysis used the residual value of the *pretest* and *posttest*. The normality of scientific reasoning skills data obtained a value of 0.45 > 0.05. To conclude, the data was normally distributed thus it could be used. The homogeneity of scientific reasoning data obtained a value of 0.20 > 0.05, which means the data was homogeneous.

Hypothesis Testing

The summary of the hypothesis testing on the potential of the learning model in improving scientific reasoning ability by using the Anacova test obtained 0.00 < 0.05 (Table 1). The results indicated that there is a potential learning model in improving scientific reasoning. Furthermore, for academic ability, a value of 0.00 < 0.05 was obtained which indicates that academic ability has an effect on scientific reasoning. The effect of the interaction of learning models and academic abilities was 0.046 < 0.05, meaning that the interaction

Table 1. The Results of Hypothesis Testing Using Anacova on The Effect of Learning Model to Scientific Reasoning

S	Type III Sm of Square	df	MS	F	Sig.
CM	20886.28	9	2320.69	60.28	0.00
I	2394.37	1	2394.37	62.19	0.00
Pre_PI	3124.69	1	3124.69	81.16	0.00
MDL	14696.76	2	7348.38	190.86	0.00
KA	2037.01	2	1018.51	26.45	0.00
MDL * KA	380.44	4	95.11	2.47	0.046

of learning models and academic abilities has the potential to improve scientific reasoning.

The summary of the treatment effect on scientific reasoning shows a value of < 0.05, therefore the learning model, academic ability, and the interaction of the learning model and academic ability have the potential to improve scientific reasoning (Table 2).

The LSD notation of the corrected mean involved the scientific reasoning of students facilitated by RICOSRE which is significantly different from guided and conventional inquiry. The corrected mean was the highest for RICOSRE. In conclusion, RICOSRE is effective at improving scientific reasoning (Table 3).

The LSD notation of corrected mean involved the scientific reasoning of students at high academic ability which is significantly different from students at low academic ability. The highest corrected mean was for students with high academic ability, namely 62.75. In conclusion, there is an effect of academic ability on improving scientific reasoning (Table 4).

The LSD notation of the corrected mean shows that the scientific reasoning of the interaction between RICOSRE and high and low academics are significantly different from the interaction between guided and conventional inquiry with high and low academic ability. The highest corrected mean was found in the interaction of RICOSRE and high academic ability, then RICOSRE with low academic ability. The corrected mean score of low academic ability exceeds the mean score of corrected inquiry in high academic ability students, thus confirming that RICOSRE is effective in improving scientific reasoning at low and high academic ability.

The interaction between RICOSRE and Academic Ability has the potential to improve scientific reasoning seen from an increase in the percentage of scientific reasoning abilities. High academic ability students have an increase (%) greater than students with low academic ability who were taught with the RICOSRE learning model. In conclusion, RICOSRE has a greater potential to improve students' scientific reasoning at both low and high academic ability.

DISCUSSION

The research confirmed the potential of the RICOSRE learning model in improving students' scientific reasoning abilities in different academic abilities. The anacova test summary affirm the potential of the learning model in improving scientific reasoning abilities and obtained a value of 0.00 < 0.05. RICOSRE has the potential to improve students' scientific reasoning skills. This is because the stages or RICOSRE syntax are able to develop students' reasoning abilities.

The *Reading* syntax on RICOSRE offers students the opportunity to deepen their knowledge. Reading trains students to process and acquire knowledge or messages of knowledge (Tarigan, 2008). Reading is able to make students find the meaning of a text. Then, these understandings are re-expressed or reproduced in the form of arguments based on knowledge (Agustina, 2008). The second stage, *Identifying the Problem,* also

Table 2. The Summary of Learning Model Potency to Improce Scientific Reasoning

Class	Pre	Post	Sel	%	RT	Nts
Conv	35.98	47.69	11.72	32.57	48.03	a
IT	37.06	57.83	20.77	56.05	57.28	b
RIC	36.11	69.09	32.98	91.31	69.30	c

Table 3. The Summary of Academic Ability Potency in Improving Scientific Reasoning

AC	Pre	Post	Sel	%	RT	Nts
Low	36.34	55.19	18.84	51.84%	54.93	a
High	36.88	63.38	26.49	71.84%	62.75	b

Table 4. The Summary of Interaction Potency in Improving Scientific Reasoning

MDL	AC	Pre	Post	Sel	%	RT	Nts
CONV	Low	37.78	44.23	6.45	17.08	43.0	a
	High	33.41	50.00	16.59	49.64	52.51	b
IT	Low	36.93	53.69	16.75	45.37	53.21	b
	High	40.35	65.79	25.44	63.04	62.40	c
RIC	Low	34.47	66.94	32.47	94.19	68.55	d
	High	37.19	74.06	36.86	99.11	73.35	e

greatly trains and develops students' scientific reasoning abilities. This activity is a continuation of the stage of *Reading* (Osborne, 2013). Reading activities are related to scientific literacy. Reading allows students to build their own concepts, contributes to observations and develops students' scientific reasoning. Reading enhances students' reasoning abilities since they are faced with a lot of information thus it needs to be selected before processing it first. Reading makes students accustomed to selecting information, processing and relating various information obtained. Reading habits also make students better able to understand discourse, describe data, graphics and pictures, so they are able to analyze the problems contained in the questions (Yore, 2003).

The stages of formulating solutions and building solutions in RICOSRE learning are closely related to students' scientific reasoning. Students are able to use knowledge and train themselves to use appropriate methods in formulating and implementing a solution to the problems that have been identified. Students need to choose the right strategy and methodology to build solutions, namely by making hypotheses in solving problems, simplifying problems, making assumptions and speculations, forming provisional hypotheses. Based on this, the students can assume a solution based on the knowledge obtained at the reading stage (Carson, 2007). Therefore, the stages of building and implementing this solution can help students develop their scientific reasoning skills.

The fourth stage in RICOSRE is *Solving the Problems* related to students' scientific reasoning abilities. Good scientific reasoning allows students to make the proper decisions in solving problems (Ding, 2014). Previous research states that an increase in scientific reasoning occurs after the application of a problem-based learning model (Ding, 2014). The fifth stage in the RICOSRE learning model is *Reviewing the Problem Solving* to obtain feedback from discussion participants or other students. This stage helps students expand the information from the investigations they carry out in solving problems (Llewellyn, 2013). The last step in the RICOSRE learning model is *Extending the problem*. This stage allows students to check the solutions they proposed and identify the most possible solutions to solve problems as well as the proper methods and strategies used in solving problems. (Mahanal & Zubaidah, 2017).

The RICOSRE learning model syntax is very beneficial in enhancing the ability of the students to think scientifically. RICOSRE consisted of activities such as reading, problems identifying, solutions forming, solutions implementing, and new knowledge building. RICOSRE learning activities are very useful in training students to think in a structured and systematic way, logically, and critically, so they can develop the scientific reasoning skills. The stages of the RICOSRE learning activities are not found in the conventional learning that teachers usually do. While studying in class , teachers in traditional learning appear to dominate, include more new information about a subject, so that they do not encourage students to develop their own knowledge.

The anacova test summary also showed the potential for academic capacity to improve the scientific reasoning of the students with a value of $0.00 < 0.05$. The scientific reasoning of the high-group students has higher score than the low-group. Students with high academics tend to be interested in the problem solving challenges and tasks (Sumiati, 2018). The problem-solving process requires students ' ability to think about using knowledge, gathering data, and formulating solutions, and it influences the logical thinking of the students. While students in the low-level academic ability group are motivated to solve problems, less questions are answered and less creative in asking questions and answers (Zubaidah, Sunarmi, & Triastono, 2000).

Based on the anacova examination, one can see that there is a possible influence on logical reasoning between the two independent variables. Results from Anacova testing demonstrate the potential for interaction between RICOSRE and academic ability in improving scientific reasoning. Previous research also indicated that various learning and academic models have an effect on problem solving, thinking creatively and critically (Mahanal, Sumiati, Zubaidah, Sari, & Ismirawati, 2018). RICOSRE 's interaction with high and low academic ability is higher than inquiry interaction with high and low low academic ability or those who learnt with conventional learning.

Students' thinking skills can be developed with RICOSRE because it is one of the lessons that requires solving a problem. The existence of a problem that must be solved makes students think complex about the situation at hand to get a solution in solving the problem, so that students indirectly also get new knowledge (Alberida, Lufri, Festiyed, & Barlian, 2018). Scientific reasoning cannot be separated from students' academic abilities. Students with high academic abilities have a high need for achievement, have higher expectations, are persistence, and show better performance in completing assignments and solving problems. Students with high academic levels will get better learning achievement than students with low academic levels. Students

in the high academic category quickly understand a material so that they are more successful in learning, while students with low academic ability are often associated with failures in education (Warouw, 2009).

The ability of students at high academic levels is more focused and systematic, conveying arguments that are supported by proven data and knowledge, so they also have high scientific reasoning abilities. Previously it was known that there was an effect of academic ability on argumentation skills (Noviyanti, Mukti, Yuliskurniawati, Mahanal, & Zubaidah, 2019).

Various academic abilities in a learning class should not be ignored. High and low academic abilities possessed by students need to be considered so that there are no gaps in learning. The interaction between RICOSRE and high and low academics did not occur significant inequality, thus in the learning process the mean scores of *posttest* of low and high students increased from the *pretest* scores with an insignificant different.

Heterogeneous grouping of students can also minimize the inequality of scores obtained by the low and high academic level groups. RICOSRE Learning forms student groups in implementing learning syntax. Each group has members with different academic abilities, so they can work together in learning. This is a solution in implementing RICOSRE thus there are no imbalances in the learning process of students with different academics.

CONCLUSION

This paper concludes that RICOSRE learning model is able to mprove scientific reasoning and there is a slight different of scientific reasoning between students with high and low academic abilities. In addition, RICOSRE learning model allows students to improve their scientific reasoning as well as decreasing the gap between students with high and low academic abilities.

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