4th International Seminar of Mathematics, Science and Computer Science Education

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Preface

The 4th International Seminar of Mathematics, Science, and Computer Science Education (MSCEIS 2017) was held in Bandung, Indonesia, on 14 October 2017. This seminar is the 4th international seminar which held annually started since 2013 hosted by Faculty Mathematics and Science Education, Indonesia University of Education. The theme of MSCEIS 2017 is promoting mathematics and science for technology and education advancement. As the scient the MSCEIS 2017 should be beneficial for all participants. This seminar facilitates researchers, lecturers, and graduate students to share, to learn, and to discuss each other on the current research topics as well as to extend scientific networking in the future. In particular, there are six keynote speakers and eight invited speakers from Australia, Japan, Malaysia, and Indonesia.

There are 296 presented orally and 62 papers presented by poster covering variety of subjects on mathematics, science, computer science and science education. 358 of papers were double blind reviewed where the number of accepted papers is 212 and the number of rejected papers is 146.

We would like to thank all of those who helped and supported MSCEIS 2017. Each individual and institution's support was very important for the success of this seminar. Specifically, we would like to acknowledge the advisory board, scientific committee, and organizing committee for their valuable advice, help, suggestion, and support in the organization and helpful peer-reviewing process of the papers. We would also extend our best gratitude to keynote speakers for their valuable contribution for sharing ideas and knowledge in the MSCEIS 2017.

We sincerely hope that MSCEIS 2017 will be a forum for excellent discussions for improving the quality of research and development relating to the mathematic, science, and computer science education. We also hope that this forum will put forward new ideas and promote collaborative researches among participants. We believe that the proceedings can serve not only as an important research source progress but also other new products and processes for better science and technology.

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Peer review statement

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Peer review statement

All papers published in this volume of *Journal of Physics: Conference Series* have been peer reviewed through processes administered by the proceedings Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

Improving the critical thinking skills of junior high school students on Earth and Space Science (ESS) materials

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Improving the critical thinking skills of junior high school students on Earth and Space Science (ESS) materials

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Abstract. Critical thinking skills need to be developed in students. With critical thinking skills, students will be able to understand the concept with more depth easily, be sensitive with problems that occur, understand and solve problems that occur in their surroundings, and apply the concepts in different situations. Earth and Space Science (ESS) material is part of the science subjects given from elementary school to college. This research is a test of research program with quantitative method. This study aims to investigate the improvement of critical thinking skills of students through training of science teachers in junior high school in designing learning media for teaching ESS. With samples of 24 science teachers and 32 students of grade 7th in junior high school which are chosen by purposive sampling in a school in *Ogan Ilir* District, South Sumatra, obtained average pre-test and post-test scores of students' critical thinking skills are 52.26 and 67.06 with an average N-gain of 0.31. A survey and critical thinking skills based-test were conducted to get the data. The results show positive impact and an increase in students' critical thinking skills on the ESS material.

1. Introduction

The development of a nation is primarily determined by the development of human resources. Human resources development is achieved through education; and science education plays an important role in the development of qualified human resources. Science education is a media for the students to learn about themselves and their environment and continue to develop it in their everyday life. The learning process is emphasized on direct experience to develop their competencies so they would be able to learn to explore the nature scientifically. Science education is directed at inquiry and doing science to help students understand the world [1].

Conducting the instruction as stated in the law of education in 2003 required skilled teachers with sufficient and professional competence. The world of education is also challenged to prepare young people with knowledge, critical thinking skills, creative thinking, and problem-solving skills to live in the future that will be full of challenges and competition. Achieving this goal requires science teachers who have the ability to prepare young people to live in the society as mentioned above. High-quality teachers are very important in contributing to the education and life of the younger generation.

The development of today's education world leads to a student-centered learning process, where students learn to construct their own knowledge. The orientation of learning has also shifted from product-oriented learning to process-oriented learning. The results of a preliminary study in one of the State Junior High School in *Ogan Ilir* District indicate that the learning process is still teachers-centered. This kind of learning process will be difficult to assist in developing students 'higher-order thinking skills, especially their critical thinking skills.

Critical thinking is the ability to make reasoning and to think reflectively that are directed to deciding the convincing things to do [2]. Critical thinking skill essentially is a problem-solving ability. Ennis designed a critical thinking curriculum consisting of 12 indicators which are grouped into five critical thinking skills groups: (1) elementary clarification, (2) basic support, (3) inference (summing up), (4) advanced clarification (making further explanation) and (5) strategy and tactics. [3]

Critical thinking is a mental activity that involves mind and heart in terms of achieving solutions, solving problems, making decisions, analyzing assumptions, evaluating, rationalizing, and investigating things that happen in the present, in the past, and in the future [4]. Critical thinking (CT) skills is an important part in all aspects of one's life. CT is used in various situations and opportunities in the effort to solve life problems. It is therefore important that one learns about how to think critically, because one will not necessarily be able to think critically without going through the learning process. CT is a skill gained through learning [5]. Thus, it is necessary to teach how to think critically to learners as early as possible [6].

ESS is one of the subjects that study the earth and space. ESS subject has become part of the education curriculum in Indonesia from elementary school to university level. Judging from its development, ESS is one of the oldest developed sciences and it serves quite important role. In the past, the nations who mastered astronomy and geology had a high level of civilization. Indonesia, as a country with a geographical specificity which is prone to disaster, requires mastery of these sciences. It will be very relevant for Indonesians if they really know and develop astronomy and geology. Unfortunately, the ability of Indonesian teachers to transfer this knowledge to their students is still low. The low ability of science teachers and the ESS teachers is inseparable from the process of preparing the teachers themselves by the teacher training institutions (*Lembaga Pendidikan Tenaga Kependidikan - LPTK*) [7]. As McDermot [8] points out, one of the important factors that affect the low performance of science education is the lack of well-prepared teachers. However, the background of science teachers who teach science materials is not only from physics but also biology and agriculture education. The preliminary study that has been conducted showed that the teachers who teach ESS are 56% from physics education, 39% from biology and 5% from agriculture [9].

This study aims to train the junior high school science teachers in one of the teacher discussion forums (*Musyawarah Guru Mata Pelajaran – MGMP*) in *Ogan Ilir* regency in designing instructional design of ESS, which then would be applied in the classroom to improve their students' critical thinking.

2. Methods

The research implemented a quantitative method with sample of 24 junior high school science teachers and 32 7th graders of a junior high school in *Ogan Ilir* regency of South Sumatera province taken by purposive sampling. Research's instrument which used were critical thinking skill-based test and survey to evaluate the students' critical thinking skill. The test was about earth and disaster structure and planetarium. Data analysis were done by normality test, homogeneity test and N-Gain using SPSS.

Before the science teachers are trained, the seventh-grade students in a junior high school in one of the public schools were given pre-test on critical thinking skills using ESS materials they have not yet learned. After that, the trained science teacher conducted their instruction in the classroom. In the end, the students were given a post of critical thinking skills about the ESS materials that they had studied. The development of students' critical thinking skills was then calculated using normalized average score (N-gain) [9] data with the following formula:

$$< g >= \frac{S_{post} - S_{pre}}{S_{m-ideal} - S_{pre}} \quad (1)$$

Notes:
$< g >$ = average score of normalized gain
S_{post} = post-test average score
S_{pre} = pre-test score average
$S_{m-ideal}$ = ideal maximum score

N-gain scores that have been obtained are then interpreted according to table 1 below.

Table 1. Interpretation of n–gain average score.

$< g >$ Value	Criteria
$< g > \geq 0{,}7$	High
$0.3 \leq < g > < 0{,}7$	Moderate
$< g > < 0.3$	Low

3. Results and Discussion

The pre-test, post-test and N-Gain scores of the students' critical thinking skills are shown in Table 2.

Table 2. Pre-test, post-test and n-gain of students' CT score

	Pre-test	Post-test	N-gain
Average	52.32	66.86	0.30

Table 2 shows that the average pre-test of critical thinking skills of students before studying ESS material is 52.32 while the post test score is 66.86 with average score of N-gain 0.30. The scores indicate an improvement, even though it is categorized as low. It was caused by the level of students' understanding about ESS which is low. The students have limit knowledge until they're given. Furthermore, the motivation of teacher in teaching was low due to administration task and changing in curriculum. In general, there is an increase in students' critical thinking skills. It can be described on Figure 1.

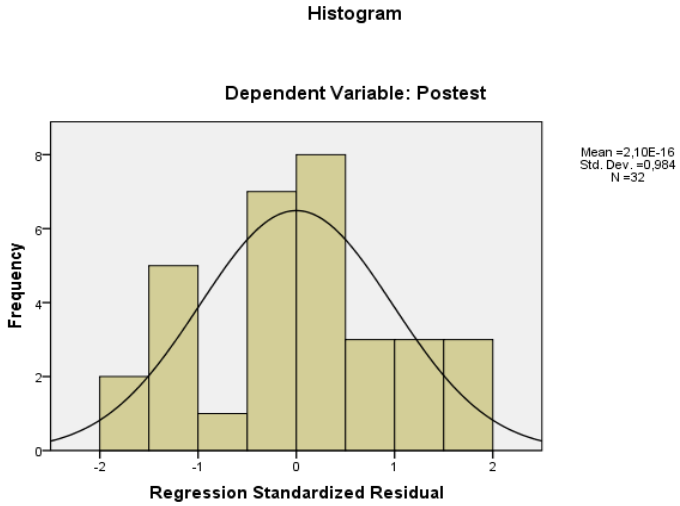

Figure 1. Histogram of post-test dependent variable.

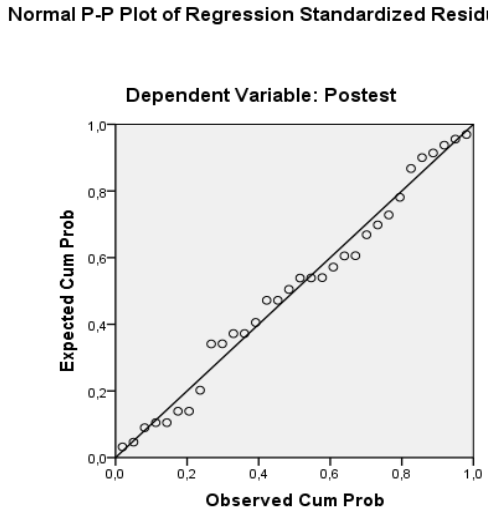

Figure 2. Normal P-P plot of regression standardized residual.

The data obtained then are tested in terms of the normality and homogeneity as the table below.

Table 3. Normality of pre-test and post-test data.

One-Sample Kolmogorov-Smirnov Test			
		Pre-test	Post-test
N		32	32
Normal Parameters [a]	Mean	52.3216	66.8616
	Std. Deviation	8.63926	7.22383
Most Extreme Differences	Absolute	.132	.134
	Positive	.101	.079
	Negative	-.132	-.134
Kolmogorov-Smirnov Z		.745	.760
Asymp. Sig. (2-tailed)		.636	.610

[a] Test distribution is Normal

Table 4. Data homogeneity.

Test of Homogeneity of Variances			
Post-test			
Levene Statistic	df_1	df_2	Sig.
3.387	10	16	.015

Table 5. ANOVA of data.

ANOVA					
Post-test					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	984.464	15	65.631	1.658	.163
Within Groups	633.230	16	39.577		
Total	1617.694	31			

Based on Table 3-5, the data are distributed normally, in which the pre-test score is 0.636 and the post test score is 0.610 > 0.05. Similarly, the above data is said to be homogeneous, which is obtained from statistics 0.163 > 0.05.

After the instruction, students are given a closed questionnaire that aims to investigate the students' level of understanding of the ESS material that has been taught by the teacher. The results of the questionnaire are shown in Figure 3:

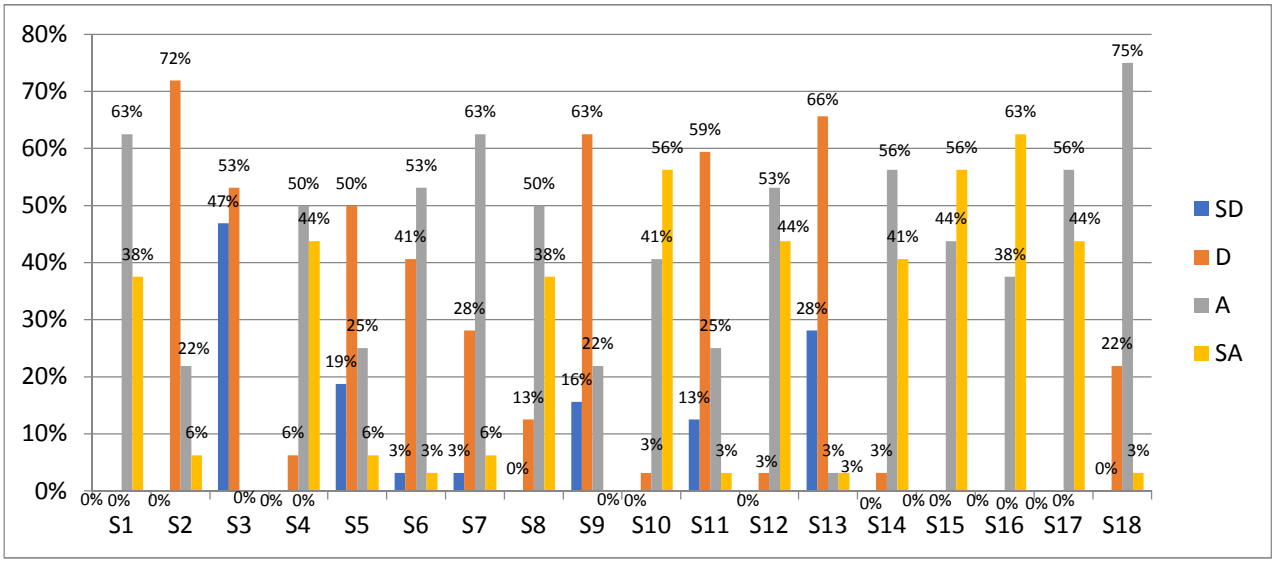

Figure 3. Students' closed questionnaires percentage.

notes:
S1: I learned interesting things in ESS materials in science subject
S2: I get poor grade in science subject related to ESS materials
S3: I think the ESS materials are boring
S4: I am happy to learn ESS materials in class
S5: It is hard to understand ESS materials
S6: I prefer science than any other subjects
S7: I think I am able to learn ESS materials quickly
S8: I am sure I can get good grades in ESS-related lesson
S9: I think ESS material is difficult to learn
S10: ESS materials are suitable to train students' critical thinking skills
S11: ESS materials are abstract

S12: I feel the benefit of ESS as I often encounter the phenomena mentioned in ESS in my Everyday life
S13: The lessons learned make me not serious about thinking solutions critically on a problem.
S14: The questions given led me to critical thinking
S15: Teacher prepares the ESS teaching media well
S16: The teacher presents the material of ESS using varied methods, media, and example in everyday life interestingly.
S17: Teachers are objective in conducting the assessment
S18: I excel in science subjects related to ESS materials

From Figure 3, it can be concluded that the teacher was success in delivering the material and students express positive statements to the material and teachers who teach ESS. The teachers were already trained so that students have more understanding and knowledge about ESS after teaching and learning activity. The students feel motivated because the teachers were professional and they were given some prize when they are pro-active in teaching and learning activity. Further, the teacher was able to correlate the subject content to God's creation and His greatness.

4. Conclusion

The results of experimental research programs that have been conducted to 7th grader in one of the public junior high schools in *Ogan Ilir* Regency in South Sumatra through training science teachers have a positive impact on improving students' critical thinking skills on the materials of ESS.

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