International Journal of Academic Research and Development
ISSN: 2455-4197, Impact Factor: RJIF 5.22
www.newresearchjournal.com/academic
Volume 1; Issue 5; May 2016; Page No. 58-63

The correlation between metacognitive skills and the critical thinking skills of the senior high school students in biology learning through the implementation of problem based learning (PBL) in Malang, Indonesia

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Abstract
To date, there have been a number of researches investigating the correlation between students' metacognitive skills and their learning results, as well as those investigating the correlation between metacognitive skills and critical thinking on the students' learning results using different learning models in biology learning. However, a research specifically investigating the correlation between metacognitive skills and critical thinking skills in biology learning through the implementation of problem-based learning (PBL) has not been conducted. This research aims to uncover the correlation between metacognitive skills and critical thinking skills of senior high school students in biology learning through the implementation of problem-based learning in Malang. This research used correlational design. The population of this research was all of senior high school students class X and XI in Malang. The samples of this research were the students of class X MIA-2 of state senior high school 8 Malang consisting of 28 students, the students of class XI MIA-1 Frateran senior high school Malang consisting of 27 students, and the students of class XI MIA-2 of Frateran senior high school Malang consisting of 28 students. The results of this research showed that 1) there is a correlation between metacognitive skills and the critical thinking skills of the students of class X with the regression equation Y = 1.0533X – 0.019 having a reliability value of 95.6%, 2) there is a correlation between metacognitive skills and critical thinking skills of the students of class X1 with the regression equation Y = 1.186X + 0.0062 having a reliability value of 89.2%, 3) there is a correlation between metacognitive skills and the critical thinking skills of the students of class X and X1 combined with the regression equation Y = 1.1775X - 0.0295 having a reliability value of 90.8%, 4) there is no difference in the slope and intercept of the regression lines of the correlation between metacognitive skills and critical thinking skills of the students of class X, XI, or the combination of class X and X1. All the regression lines are parallel and coincide with each other.

Keywords: metacognitive skills, critical thinking, PBL, biology learning

Introduction
To date, there have been a number of researches investigating the correlation between variables. For examples, the research investigating the correlation between metacognitive skills and students' learning results was conducted by Basith (2010) [1]. using jigsaw learning model. He reported that there was a correlation between metacognitive skills and the students' learning results having contribution of 66.6%. A similar research was conducted by Zen (2010) [2]. using the problem-based learning, found that the metacognitive skills had contribution on students' learning results as much as 43.7%. He also revealed that there was a correlation between metacognitive skills and students' learning results in the implementation of inquiry learning model, and the results showed that metacognitive skills had contribution on the students' learning results as much as 69%. Ardila (2013) [3]. conducting a research on biology learning using Think Empowerment by Questioning (TEQ) learning, found that the metacognitive skills had a contribution to students' learning results as much as 52.9%. Fauziyah (2013) [4], implementing TPS learning, found that metacognitive skills had a contribution to students' learning results as much as 32.5%. Similarly, Siswati (2014) [5]. found that there was a correlation between metacognitive skills and students' learning results, in relation to the implementation of jigsaw, TPS, cooperative script, reciprocal teaching, PBL, TEQ, and TEQ intergrated with TPS learning strategies. Moreover, there have been some researches investigating the correlation between two independent variables and one dependent variable such as, the research investigating the correlation between metacognitive skills and critical thinking skills on the students' learning results using problem based learning conducted by Malahayati (2014) [6]. She found that metacognitive skills had a contribution of 28.86% and critical thinking had contribution of 46.16% on students' learning results, so the total contribution was 75.02%. Furthermore, a research by Wicaksono (2014) [7]. using reciprocal teaching found that metacognitive skills had a contribution of 30.70%, and critical thinking skill had a contribution of 41.99% on cognitive learning results (the total contribution was 72.7%). Danial (2010) [8]. stated that problem based learning model could empower students' metacognitive skills because it aimed at the students' active involvement both physically and mentally in the process of problems solving constructed in the form of questions and solved through a cooperative group work. Aisyah & Ridlo (2015) [9]. found that problem based learning could empower students' metacognitive skills. Problem-based learning also has the potential to empower students' critical thinking skills. This is supported by a statement of Tan (2003) [10]. stating that

problem based learning involved group discussion solved the problem systematically, so that students could empower, train, examine, and develop their thinking skills continually. In other words, if teachers implement problem-based learning in the learning activity, the metacognitive skills and critical thinking skills of the students will developed. It is because the steps and the activities of problem-based learning includes planning the steps be used in completing the learning tasks, doing the steps or actions needed for completing the tasks, and reflecting and evaluating the learning results. These activities are parts of metacognitive skills, and problem-solving skills are parts of the critical thinking skills.

The implementation of problem-based learning in Biology learning has been proven to empower metacognitive skills on students' learning results, or metacognitive skills and critical thinking (simultaneously) on students'learning results (Zen, 2010; Siswati, 2014; Malahayati, 2014) [2, 5, 6]. Therefore, it can be said that metacognitive skills has a correlation with learning results, and metacognitive skills combined with critical thinking skills have a correlation with the students' learning results. Metacognitive skills also have a significant correlation with the critical thinking skills (Corebima, 2009) [11]. This is consistent with the research results of Hassani & Rahmatkhah (2014) [12] in the English as a Foreign Language (EFL) program in Iran and the research results of Arslan (2015) [13] in the Structural Equation Modeling subject at the University of Sakarya Turkey, stating that there was a positive correlation between metacognitive skills and students' critical thinking skills. There is not any research specifically investigating the correlation between metacognitive skills and critical thinking skills in biology learning through using the problem-based learning. Therefore it is necessary to uncover especially the correct correlation as well as its' regression equation, between metacognitive skills and critical thingking skills in any biology learning using problem-based learning.

The aim of this research is to investigate the correlation between metacognitive skills and critical thinking skills of senior high school students in biology learning using problem-based learning in Malang. The results of this research are expected to be beneficial for students, teachers and schools, namely: 1) as a means to develop students' metacognitive skills and critical thinking skills, 2) as a reference to improve the performance and the roles of the teacher as a facilitator, motivator and mediator in biology learning to empower the metacognitive skills and critical thinking skills, and 3) one of the alternatives for teachers of other subjects to empower students' metacognitive skills and critical thinking skills through the implementation of problem-based learning.

Methods

This research used a correlational design conducted at state senior high school 8 Malang and Frateran senior high school Malang. The population of this research was all the students of class X and all the students of class XI in Malang city. The samples of this research were class X MIA-2 of state senior high school 8 Malang consisting of 28 students, class XI MIA-1 of Frateran senior high school Malang consisting of 27 students, and class XI MIA-2 of Frateran senior high school Malang consisting of 28 students. The samples of this research were determined by random sampling technique. The learning instruments were the syllabus, lesson plan, student worksheet, and tests. The instruments used in this research included the rubric of metacognitive skills and critical thinking skills. The data were analyzed using simple regression analysis using SPSS software for Windows and performed at the 5% significance level.

Results and Discussion

The Correlation between metacognitive Skills and the critical Thinking Skills of Class X Students

The correlation between the metacognitive skills and the critical thinking skills of class X students can be seen in Table 1 to Table 3. The results of the analysis in Table 1 - Table 3 show that there is a correlation between the metacognitive skills and the critical thinking skills of class X students in the implementation of problem based learning. Furthermore metacognitive skills have a contribution on the critical thinking skills as much as 95.6%. The linear regression equation related is Y = 1.0533X - 0019.

Table 1: Summary of Anova of the Correlation Regression between the metacognitive Skills and the critical Thinking Skills of Class X Students

ANOVA [b]						
Model		**Sum of Squares**	**df**	**mean Square**	**F**	**Sig.**
1	Regression	10,800	1	10,800	564 763	.000 [a]
	Residual	.497	26	.019		
	Total	11.297	27			
a. Predictors: (Constant), metacognitive skills corrected						
b. Dependent Variable: Critical thinking skills corrected						

Table 2: Summary of the Correlation Analysis between the metacognitive Skills and the critical Thinking Skills of Class X Students

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.978 [a]	.956	.954	.13829
a. Predictors: (Constant), metacognitive skills corrected				

Table 3: The Regression Coefficient of the Correlation between metacognitive Skills and the critical Thinking Skills of Class X Students

coefficients [a]						
Model		**unstandardized Coefficients**		**standardized Coefficients**	**T**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	-.020	.045		-.454	.654
	Metacognitive skills corrected	1.054	.044	.978	23.765	.000
a. Dependent Variable: Critical thinking skills corrected						

The Correlation between metacognitive Skills and the critical Thinking Skills of Class XI Students

The correlation between metacognitive skills and the critical thinking skills of class X1 students can be seen in Table 4 to Table 6. The results of the analysis in Table 4 - Table 6 show that there is a correlation between the metacognitive skills and the critical thinking skills of class XI students in the implementation of problem based learning. Furthermore metacognitive skills have a contribution on the critical thinking skills as much as 89.2%. The linear regression equation related is Y = 1.186X + 0.0062.

Table 4: The Summary of Anova of the Correlation Regression between the metacognitive Skills and the critical Thinking Skills of Class XI Students

ANOVA [b]						
Model		**Sum of Squares**	**df**	**mean Square**	**F**	**Sig.**
1	Regression	36.614	1	36.614	437.791	.000 [a]
	Residual	4.433	53	.084		
	Total	41.046	54			
a. Predictors: (Constant), metacognitive skills corrected b. Dependent Variable: Critical thinking skills corrected						

Table 5: The Summary of the Correlation Analysis between the metacognitive Skills and the critical Thinking Skills of Class XI Students

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.944 [a]	.892	.890	.28919
a. Predictors: (Constant), metacognitive skills corrected				

Table 6: The Regression Coefficient of the Correlation between metacognitive Skills and the critical Thinking Skills of Class XI Students

coefficients [a]						
Model		**unstandardized Coefficients**		**standardized Coefficients**	**t**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	.007	.078		.089	.929
	Metacognitive skills corrected	1.186	.057	.944	20.923	.000
a. Dependent Variable: Critical thinking skills corrected						

The Correlation between metacognitive Skills and the critical Thinking Skills of the Students of combined Class (Class X and Class XI)

The correlation between metacognitive skills and the critical thinking skills of the combined class students can be seen in Table 7 until Table 9. The results of the analysis in Table 7 until Table 9 show that there is a correlation between metacognitive skills and the critical thinking skills of the students of class X combined with XI in the implementation of problem based learning. Furthermore the metacognitive skills have a contribution on the critical thinking skills as much as 90.8%. The linear regression equation related is Y = 1.1775X - 0.0295.

Table 7: Summary of Anova of the Correlation Regression between the metacognitive Skills and the critical Thinking Skills of the Students of the combined Class

ANOVA [b]						
Model		**Sum of Squares**	**Df**	**mean Square**	**F**	**Sig.**
1	Regression	53.496	1	53.496	798.140	.000 [a]
	Residual	5.429	81	.067		
	Total	58.925	82			
a. Predictors: (Constant), metacognitive skills corrected						
b. Dependent Variable: Critical thinking skills corrected						

Table 8: Summary of the Correlation Analysis between the metacognitive Skills and the critical Thinking Skills of the Students of the combined Class

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.953 [a]	.908	.907	.25889
a. Predictors: (Constant), metacognitive skills corrected				

Table 9: The Regression Coefficient Equation of the Correlation between metacognitive Skills and the critical Thinking Skills of the Students of the combined Class

coefficients [a]						
Model		**unstandardized Coefficients**		**standardized Coefficients**	**T**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	-.030	.053		-.561	.577
	Metacognitive skills corrected	1,178	.042	.953	28.251	.000
a. Dependent Variable: Critical thinking skills corrected						

Based on the three regression analysis, it is uncovered that there is a very significant positive correlation between metacognitive skills and critical thingking skills having the contribution as much as 89,2 - 95,6%. Therefore, the more increased the metacognitive skills are, the more increased the critical thingking skills will be.

Basically, metacognitive skills and critical thinking are significantly correlated. One of the elements supporting the critical thinking skills was metacognition. Metacognition plays a role in the critical thinking because critical thinking activities such as planning, monitoring, and assessing the development of a task completion is the nature of metacognition (Livingston, 1997) [14]. Hapern (1998) [15], stated that someone's ability to to control his cognitive activities, called metacognition, had a very significant correlation with the students' critical thinking skills. Students should have metacognitive skills to improve their critical thinking skills by monitoring their thinking process, whether the process undertaken is in accordance with the expected goals, being confident in determining the completion time and final results. Students' Critical thinking skills can be facilitated when the students use their metacognition (Magno, 2010) [16].

Dwyer, *et al* (2014) [17]. Suggested that metacognitive skills had a very significant correlation with the critical thinking skills because critical thinking was a metacognitive process that, when used properly, could give solutions to the problems faced, give logical ideas as well as could give an appropriate conclusion. This means that critical thinking skill is the product of metacognitive skills. Based on the experts' statement about the correlation between metacognitive skills and the critical thinking skills, it can be concluded that metacognitive skills and critical thinking are correlated to each other, because critical thinking skills basically involve metacognitive skills. Therefore, metacognitive skills can empower the critical thinking skills.

The results of this research are consistent with the results of Garcia & Pintrich (1992) [18]. proving that metacognitive skills had a positive correlation with the critical thinking skills. Hassani & Rahmatkhah (2014) [12] also revealed that there was a positive correlation between metacognitive skills and the critical thinking skills of the male students in English as a Foreign Language (EFL) program in Iran with a correlation coefficient (r) of 0.512, and there was a positive correlation between metacognitive skills and the critical thinking skills of the female students in English as a Foreign Language (EFL) program in Iran with a correlation coefficient (r) of 0.533. Amiri & Ahmadi (2014) [19]. in their research reported that there was a positive correlation between metacognitive skills and the critical thinking skills of students in the English as a Foreign Language (EFL) program in Iran. Similarly, the results of the research by Arslan (2015) [13] revealed that there was a positive correlation between metacognitive skills and the critical thinking skills of students in the subject of Structural Equation Modeling at the University of Sakarya, Turkey.

The results of this research confirm that metacognitive skills have a big contribution on the critical thinking skills. Therefore, teachers should facilitate the students with learning activities that can empower students' metacognitive skills and critical thinking skills in the learning process. The learning process will be able to make students have the ability to solve problems, to make the mature decisions, and to become independent thinkers being ready to live in a real life.

ANOVA Test of 3 Regression Equations of the Correlation between metacognitive Skills and critical Thinking Skills of the Students of Class X, Class XI and Class X Combined with Class XI

The differences in the regression equations between metacognitive skills and critical thinking skills in problem based learning can be determined by using ANOVA test of the regression equation. The summary of the ANOVA test of the regression equations between metacognitive skills and critical thinking skills of the students of class X, XI and class X combined with class XI can be seen in Table 10.

Table 10: Summary of ANOVA Test of the Regression Equations between metacognitive Skills and critical Thinking Skills of the Students of Class X, XI and Class X combined with Class XI

Model		Sum of Squares	df	mean Square	F	Sig.
	Regression	107.4916	5	21.49832	332.0566	0.000
	b1, b2	0.136664	2	0.068332	1.055437	0.350
	b1, b2, b3	0.499346	4	0.124837	1.928187	0.108
	Residual	10.35887	160	0.064743		
	Total	117.8505	165			

Result: parallel

Result: coincide

The analysis of ANOVA test shows the value of b1, b2 (0.350) > 0.05 and the values of b1, b2, b3 (0.108) > 0.05. The values indicate that the regression equations of the correlation between metacognitive skills and critical thinking skills of the students of class X, XI and class X combined with class XI are parallel and coincide.

The regression lines of the correlation between metacognitive skills and critical thinking skills of the students of class X, XI and class X combined with class XI are parallel and coincide. The parallel regression lines show that the slopes of the regression lines equations of the correlation between metacognitive skills and critical thinking skills of the students of class X, XI and class X combined with class XI are not different to each other. On the other hand the intercepts of the regression lines equations of the correlation related are not different to each other too. It means that the rate and size of the increase in students' critical thinking skills influenced by metacognitive skills in each class implementing problem-based learning are the same to each other.

Siswati (2014) [5], stated that there were several factors affecting the value of the slopes and the intercepts, namely the different number of students in each class, teachers' behavior in teaching learning process, students' behavior during the learning process, learning model implemented by teachers in the classroom, and many other factors. There are various factors influencing the slope and intercept, but the most

potential factors possibly influencing the slope and intercept which were not different to each other in this research were the teachers' behavior and habits in teaching and learning, and the same learning model implemented by teachers in each class.

Conclusions and Recommendations

Conclusion

Based on the results of data analysis and discussion, it can be concluded that 1) there is a correlation between metacognitive skills and critical thinking skills of the students of class X with the regression equation of the correlation between the two variables as Y = 1.0533X – 0019, having contribution value of 95.6%, 2) there is a correlation between metacognitive skills and critical thinking skills of the students of class X1 with regression equation of the correlation between the two variables as Y = 1.186X + 0.0062, having contribution value of 89.2%, 3) there is a correlation between metacognitive skills and critical thinking skills of the students of class X combined with class X1 with regression equation of the correlation between the two variables as Y= 1.1775X - 0.0295, having contribution value of 90.8%, 4) there is no difference related to the slopes and intercepts of the linear regression equations of the correlation between metacognitive skills and critical thinking skills of the students of all classes involved indicated by the regression lines which are parallel and coincide with each other. Based on the conclusions number 1 until 4, it can be further stated that the regression line equations of the correlation between metacognitive skills and critical thinking skills at different levels of education, relatively remains the same provided that all the factors influencing the slope and intercept are the same.

Recomendations

Metacognitive skills have been proven to empower students' critical thinking skills in the implementation of problem based learning model. Therefore, further research investigating the correlation between metacognitive skills and critical thinking skills, and several different variables in problem based learning needs to be conducted.

References

1. Basith A. Hubungan Keterampilan Metakognitif dan Hasil Belajar Matapelajaran IPA pada Siswa Kelas IV SD dengan Strategi Pembelajaran Jigsaw dan Think Pair Share (TPS). (The Correlation between metacognitive Skills and Natural Science Learning Results of Class IV Elementary School Students at the Implementation of Jigsaw and Think Pair Share (TPS) Learning Strategy) (Unpublished Undergraduate Thesis), State University of Malang, Indonesia, 2010.
2. Zen AR. Hubungan Keterampilan Metakognitif dan Hasil Belajar Siswa Kelas IV Sekolah Dasar (SD) dalam Pembelajaran Sains pada Penerapan Strategi Pembelajaran Problem Based Learning (PBL) dan Inkuiri (The Correlation between metacognitive Skills and the Students' Learning Results of Class IV Elementary School in Science Learning implementing of Problem Based Learning (PBL) and Inquiry Learning Strategy) (Unpublished Undergraduate Thesis), State University of Malang, Indonesia, 2010.
3. Ardila C. Hubungan Keterampilan Metakognitif Terhadap Hasil Belajar Biologi dan Retensi Siswa Kelas X Dengan Penerapan Strategi Pemberdayaan Berpikir Melalui Pertanyaan (PBMP) Di SMAN 9 Malang (The Correlation between metacognitive Skills and the Biology Learning Results, metacognitive Skills and Retention of Class X Students at the Implementation of Thinking Empowerment by Questioning (TEQ) In SMAN 9 Malang) (Unpublished Undergraduate Thesis), State University of Malang, Indonesia, 2013.
4. Fauziyah DR. Hubungan Keterampilan Metakognitif Terhadap Hasil Belajar Biologi dan Retensi Siswa Kelas X Dengan Penerapan Strategi Pembelajaran Think Pair Share Di SMA Negeri 6 Malang (The Correlation between metacognitive Skills and Biology Learning Results, metacognitive Skills and Retention of Class X Students at the Implementation of Think Pair Share Learning Strategy In SMAN 6 Malang) (Unpublished Undergraduate Thesis), State University of Malang, Indonesia, 2013.
5. Siswati BH. Hubungan antara keterampilan metakognitif dengan hasil belajar siswa berkemampuan akademik berbeda pada pembelajaran biologi yang menerapkan beberapa model pembelajaran. Tesis tidak diterbitkan. Malang: PPs Universitas Negeri Malang. (The Correlation between metacognitive Skills with the Learning Outcomes of the Students having different academic Ability in Biology Learning applying some different Learning Model) (Unpublished Magister Thesis), State University of Malang, Indonesia, 2014.
6. Malahayati EN. Hubungan keterampilan metakognitif dan kemampuan berpikir kritis dengan hasil belajar biologi siswa yang menjalani pembelajaran Problem Based Learning (PBL) pada kelas XI SMA di Kota Malang (The Correlation of metacognitive Skills and critical Thinking Skills on the Students' Biology Learning Results of class XI Senior High Schools in Malang in the Implementation of Problem Based Learning (PBL) (Unpublished Magister Thesis), State University of Malang, Indonesia, 2014.
7. Wicaksono AGC. Hubungan keterampilan metakognitif dan berpikir kritis terhadap hasil belajar kognitif siswa SMA pada pembelajaran biologi dengan strategi reciprocal teaching di Kabupaten Malang (The Correlation of metacognitive Skills and critical Thinking on the Students' cognitive Learning Results of senior high Schools in Biology Learning implementing of Reciprocal Teaching Strategy in Malang) (Unpublished Magister Thesis), State University of Malang, Indonesia, 2014.
8. Danial M. Pengaruh Strategi PBL Terhadap Keterampilan Metakognisi dan Respon Mahasiswa (The Effect of PBL Strategy on Students' metacognitive Skills and Response. Jurnal Chemica. 2010; 11(2):1-10.
9. Aisyah S, Ridlo S. Pengaruh Strategi Pembelajaran Jigsaw dan Problem Based Learning Terhadap Skor Keterampilan Metakognitif Siswa Pada Mata Pelajaran Biologi (The Effect of Jigsaw and Problem Based Learning Strategy on the Students' metacognitive Skills in Biology Learning). Unnes Journal of Biology Education. 2015; 4 (1): 22-28.
10. Tan OS. Problem Based Learning Innovation: Using Problem To Power Learning In The 21st Century. Singapore, 2003, 59-70.

11. Corebima AD. Pengalaman Berupaya Menjadi Guru Profesional. Pidato Pengukuhan Guru Besar dalam Bidang Genetika pada Fakultas Matematika dan Ilmu Pengetahuan Alam. Disampaikan pada sidang terbuka senat Universitas Negeri Malang tanggal 30 Juni 2009 (Experience to become a professional Teacher. Inauguration Speech in the Field of Genetics at the Faculty of Mathematics and Natural Sciences). Presented at the open Session of the Senate of State University of Malang, Indonesia, 2009.
12. Hassani MT, Rahmatkhah M. The Relationship between EFL Learners Metacognitive Strategies, and Their Critical Thinking. Journal of Language Teaching and Research. 2014; 5(5):1167-1175.
13. Arslan S. Investigating Predictive role of Critical Thinking on Metacognition with Structural Equation Modeling. The Malaysian Online Journal of Educational Science. 2015; 3(2):1-10.
14. Livingston JA. Metacognition, 1997. An Overview. http://gse.buffalo.edu/fas/shuell/cep564/metacog.htm. accessed on March 1, 2016.
15. Halpern DF. Teaching critical thinking across domains: dispositions, skills, structure training, and metacognitive monitoring. American Psychologist. 1998; 53(4):449-455.
16. Magno C. The role of metacognitive skills in developing critical thinking. Article In Metacognition and Learning. 2010; 5(2):137-156.
17. Dwyer CP, Hodent-centred conceptualisation of critical thinking: a case study. Education Tech Research Dev. 2014; 62:687-709.
18. Garcia T, Pintrich PR. Critical Thinking and Its Relationship to Motivation, Learning Strategies, and Classroom Experience. Paper presented at the Annual Meeting of the American Psychological Association 100th, Washington DC, 1992.
19. Amiri BM, Ahmadi Z. The Relationship Between EFL Learners' Critical Thinking, And Metacognitive Strategies. International Journal of Language Learning and Applied Linguistics World (IJLLALW). 2014; 5(1):488-505.