Exploring the Correlation between Metacognitive Skills and Retention of Students in Different Learning Strategies in Biology Classroom

Arsad Bahri[1)]

[1)]*Department of Biology, Faculty of Mathematics and Natural Science, Universitas Negeri Makassar*
Jl. Daeng Tata Raya, Kampus UNM Parangtambung, Makassar, South Sulawesi, Indonesia

Email: arsad.bahri@unm.ac.id

Abstract. Metacognitive skills were believed to contribute on vary of cognitive activity of students, including the retention. This research was conducted during one semester in four different classes that were taught biology by using four different learning strategies: Problem-based Learning (PBL), Reading Questioning and Answering (RQA), PBL integrated with RQA (PBLRQA), and multi-strategy. This research explored the correlation between metacognitive skills with retention of students in the four different strategies, and compared the four regression lines whether or not they are parallel. The research results showed that the correlations between metacognitive skills and students' retention were significant. The results of the analysis of variance related to the regression equation in the four different strategies were parallel and not coincide and the regression line of RQA strategy was at the highest position. It indicated that this strategy has the potency to empower metacognitive skills and simultaneously maintained the students' retention. It would be important information for lecturers that they should empower the metacognitive skills through the appropriate learning strategies because it was believed could affected the students' retention.

Keywords: metacognitive skills, retention, problem-based learning, reading questioning answering, regression line.

INTRODUCTION

Metacognition is awareness of one's thinking about the thinking process. Metacognition was thinking about thinking (Livingston, 1997; Flavell, 1999), knowledge of self-learning or about learn how to learn (McCormick, 2003, in Slavin, 2006). Metacognition was divided into three types of thinking that metacognitive knowledge, metacognitive skills, and metacognitive experience (Hacker, et al. 2009; Downing et al., 2009).

Metacognitive skills conceptualized as an interconnected set of competencies. Dawson (2008), Anderson & Krathwohl (2001) explained that these competencies used for learning and thinking, and skills required for active learning, critical thinking, problem solving, and reflective assessment. Four indicators of metacognitive skills were planning, monitoring, evaluating, and revising (Lee & Baylor, 2006). First, planning is an activity that is done carefully regulating the whole process of learning. Behavior plan consists of a set of learning objectives, sequence learning, learning strategies and expectations of the current study. Second, monitoring refers to moderate activity on learning progress. Monitoring activities are monitoring during learning activities. Thirdly, evaluating refers to the self-evaluation of learning process includes an assessment of learning activities progress. Fourth, revising refers to revise the learning process, which includes the plan modification of the previous goals, strategies, and other learning approaches. Livingston (1997) stated that a person's cognitive activities such as planning, monitoring, and evaluating the completion of a particular task were a metacognition.

Metacognition make students become self-regulated learners who can plan and organize their learning process. Livingston (1997) explained that metacognition played a role in learning success. Eggen & Kauchak (1996) suggested that the development of skills in students was a valuable educational purpose, since those skills could help them become self-regulated learners. Self-regulated learner was responsible for their own learning progress and adapted their learning strategies to achieve mastery learning (Anderson & Krathwohl,

2001). Learners who skillfully in self-assessment would aware of their ability, to act more strategically, and better than those who were not skilled in self-assessment (Schraw & Dennison, 1994).

Several studies about the correlation between metacognition with achievement have been reported primarily associated with the implementation of specific instructional strategies. Coutinho (2007), Rahman (2010). Atunasikha (2010), Mustaqim et al. (2013), and Bahri and Corebima (2015) found that metacognitive skills contributed to the cognitive learning outcomes of students. Correspondingly, Zimmerman (1990) also found that the self-regulated learning has a strong relationship with achievement. Metacognitive skills also contributed to the students' motivation (Salili et al., 2001; Kuntjojo, 2012; Bags, et al., 2012; and Mustaqim, et al., 2013).

Theoretically metacognition has believed to have a correlation with student retention. Retention was the ability to remember the subject matter until a specified period was the same as the material being taught (Anderson & Krathwohl, 2001). Remembering is taking the necessary knowledge of long-term memory. According to Dahar (1991) related to the length of material retention lessons learned learners in memory. Retention is the amount of acquisition of learning outcomes that are still able to remember or reproduced by learners after a certain time in its memory. Koffka (1965) in Hergenhahn & Oslon, (2009) explained that memory process was the activity in the brain caused by environmental experience, when the process stops, and the effect is still lagging behind traces in the brain. Furthermore, Koffka (1965) stated that if one defines learning as a potential modification of behavior that comes from experience, each occurrence could be viewed as a learning experience. Metacognitive skills are believed to play an important role in cognitive activities include memory (Howard, 2004).

Previous research on the relationship between metacognition with retention on the application of biology learning strategies has not been widely reported. The use of appropriate learning strategies to empower students' metacognition, believed can simultaneously improve cognitive retention of students. The use of different biology learning strategies is possibility to show different correlations between students' metacognition with students' retention. Biology can be thought by variety of learning strategies, such as problem-based learning (PBL), Reading Answering and Questioning (RQA), the integration of PBL with RQA (PBLRQA), and traditional learning. Skaalvik & Skaalvik (2010); Baran & Maskan (2011); and Kristiani et al. (2015); Muhiddin (2016) reported on the correlation between the variables and other variables in different conditions and different fields of knowledge. It is also possible that there is a distinct correlation between metacognition with students' retention in a variety of biology learning strategy. Therefore, it is necessary to explore the correlation between metacognition with students retention.

Based on the background above, it is necessary to conduct the research to explore the correlation between metacognition with students' retention of use four different learning strategies. Those learning strategy is PBL, RQA, PBLRQA, and traditional learning. The results of this research can be valuable information for the teacher to select appropriate learning strategies in biology classroom that not only enhance students' cognitive learning outcomes, but also can empower student metacognition and increase students' retention.

METHODS

This study was a quasi-experiment, designed to explore the correlation between metacognitive skills with the retention of students taught by different biology learning strategies namely: Problem-based Learning (PBL), Reading Questioning and Answering (RQA), the integration of PBL and RQA (PBLRQA), and multi-strategy. The study was conducted on students at the Faculty of Mathematics and Natural Sciences at the Universitas Negeri Makassar, Indonesia in 2014. The research sample obtained by random sampling to early academic skills homogeneous grouping based test as many as 142 students of the first semester distributed into four classes. Metacognitive skills of students measured using essay test that was integrated with tests of cognitive learning outcomes and students' retention. Instruments were valid and reliable. During one semester, the four classes were taught by treatment with different learning strategies. Metacognitive skills test was given at the beginning and end of the semester. Retention test was given two weeks after the end semester.

RESULTS AND DISCUSSION

Results

Multi-strategy

The results of the data analysis related to the correlation regression equation between metacognitive skills and retention of students in the implementation of multi-strategy are illustrated in Table 1.

Table 1. The regression correlation coefficient of metacognitive skills and students' retention in multi- strategy

	Unstandardized Coefficients		Standardized Coefficients		
	B	**Std. Error**	**Beta**	**t**	**P**
(Constant)	0.536	3.395		0.158	0.875
Metacognitive Skills	-0.700	0.118	-0.715	-5.957	0.000

The results of the data analysis in Table 1 show that the correlation regression equation between metacognitive skills and cognitive retention of students in the implementation of multi-strategy was statistically significant. The contribution value related is 0.15, meaning that the contribution of metacognitive skills and cognitive retention of students is 51,1%, and the contribution of the factors other than metacognitive skills is 48,9%.

PBL Strategy

The results of the data analysis related to the correlation regression equation between metacognitive skills and retention of students in the implementation of PBL are illustrated in Table 2.

Table 2. The regression correlation coefficient of metacognitive skills and students' retention in *PBL*

	Unstandardized Coefficients		Standardized Coefficients		
	B	**Std. Error**	**Beta**	**t**	**P**
(Constant)	-3.877	4.870		-0.796	0.432
MetacognitiveSkills	-0.326	0.129	-0.397	-2.522	0.017

The results of the data analysis in Table 2 show that the correlation regression equation between metacognitive skills and cognitive retention of students in the implementation of PBL was statistically significant. The contribution value related is 0.15, meaning that the contribution of metacognitive skills and cognitive retention of students is 15,8%, and the contribution of the factors other than metacognitive skills is 84,2%.

RQA Strategy

The results of the data analysis related to the correlation regression equation between metacognitive skills and retention of students in the implementation of RQA are illustrated in Table 3.

Table 3. The regression correlation coefficient of metacognitive skills and students' retention in *RQA*

	Unstandardized Coefficients		Standardized Coefficients		
	B	**Std. Error**	**Beta**	**t**	**P**
(Constant)	5.946	4.903		1.213	0.234
MetacognitiveSkills	-0.317	0.139	-0.374	-2.279	0.030

The results of the data analysis in Table 3 show that the correlation regression equation between metacognitive skills and cognitive retention of students in the implementation of RQA was statistically significant. The contribution value related is 0.15, meaning that the contribution of metacognitive skills and cognitive retention of students is 14%, and the contribution of the factors other than metacognitive skills is 86%.

PBLRQA Strategy

The results of the data analysis related to the correlation regression equation between metacognitive skills and retention of students in the implementation of PBLRQA are illustrated in Table 4.

Table 4. The regression correlation coefficient of metacognitive skills and students' retention in *PBLRQA*

	Unstandardized Coefficients		Standardized Coefficients		
	B	**Std. Error**	**Beta**	**t**	**p**
(Constant)	6.260	6.909		0.906	0.371
Metacognitive Skills	-0.344	0.141	-0.387	-2.446	0.020

The results of the data analysis in Table 4 show that the correlation regression equation between metacognitive skills and cognitive retention of students in the implementation of PBLRQA was statistically significant. The contribution value related is 0.15, meaning that the contribution of metacognitive skills and cognitive retention of students is 15% and the contribution of the factors other than metacognitive skills is 85%.

Regression line of metacognitive skills with students' retention in four learning strategies were compared with each other to determine the alignment and coincidence between all of regression line and to determine the learning strategies that have the highest correlation between metacognitive skills with students' retention. The comparison of regression line between the four learning strategies is shown in Figure 1.

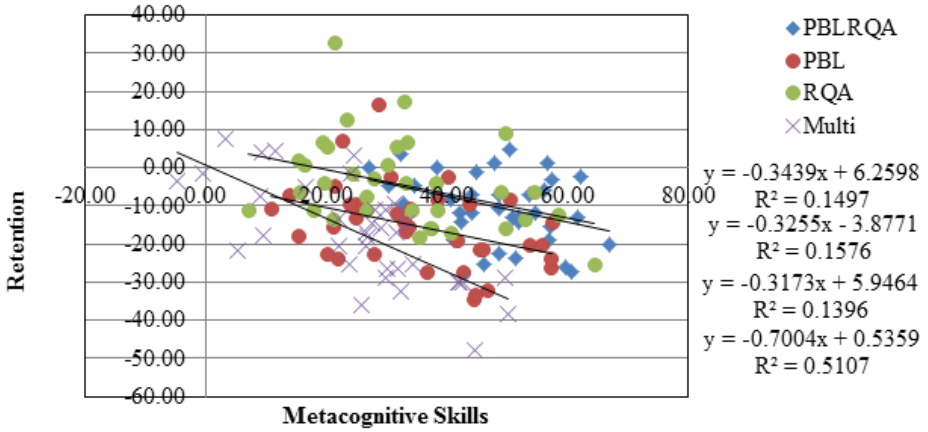

Figure 1. Regression line of metacognitive skills and students' retention in four teaching strategies

Figure 1 showed that the traditional learning strategies, students' retention tends to decrease drastically. The different thing is indicated by PBLRQA strategy, PBL and RQA, where, in the same time, retention of students has decreased gradually. Figure 1 also showed the graph of the ANOVA test related to regression equation of correlation between metacognitive skills and students' retention in the four different learning strategies appears that the regression line of RQA is the highest than those of the other three strategies with the regression coefficient -0.3173.

The results of the analysis of variance related to correlation regression equation between students' metacognitive skills and their retention in the four different strategies are illustrated in Table 5.

Table 5. Summary of the ANOVA test result of the regression equation of the correlation

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Regression	30425,515	7	4346,502	250,641	0,000
b3,b5	72,792	2	36,396	2,099	0,241
b2,b3,b4,b5	364,461	6	60,743	3,503	0,048
Residual	2323,768	134	17,342		

Result: parallel & not coincide

ANOVA test result indicates that the value of b3, b5 is 0.241 (>0.05), but the value of b2, b3, b4, b5 is 0.048 (<0.05). Those values prove that the regression lines related to the correlation between the students' metacognitive skills and their retention are parallel to each other, as well as do not coincide.

Discussion

The result of the study indicated that the correlation between metacognitive skills with students' retention was statistically significant. The results are consistent with research result by Muhiddin (2016) and Bahri (2016) who reported that there was a correlation between metacognitive skills with students' retention. According to Anderson & Krathwohl (2001), metacognitive useful to help students found a variety of learning strategies that can be used to memorize the course material, looking for the meaning of the text, or understand what they studied in the classroom or on from reading a book. Memorizing the subject matter associated with retention.

Metacognition was a strong predictor of academic success (Dunning, et al., 2003; Countinho, 2007). It is further mentioned that learners who have good metacognition will have a good achievement anyway. The students can improve their academic performance through training metacognition. Similarly, O'Malley and Chamot (1990) and Ellis (1999) mentioned that a student without a metacognitive approach could not review their learning progress and achievements. Flavell (1979) stated that metacognition played an important role in the learning process. Students who were learning have the skills to manage and control their learning process (Uno, 2008).

Thinking as activities that involve mental processes requires the ability to remember and understand, and to be able to remember and understand the necessary mental process (thinking). Sanjaya (2008) explained that the ability to think was definitely followed by the ability to remember and understand. Thus, metacognition have a positive correlation with retention. Others, Kauchak & Eggen (2007) mentioned that metacognition, and content knowledge related to each other. The learners who have metacognition mean that learners are able to regulate and control the cognitive processes so that knowledge can also be increased. Learners who have the metacognitive skills will demonstrate understanding of the concept. On the basis of this relationship, metacognition is also associated with retention. Therefore, if the students have a high metacognition, then their retention also be high.

This statement is in line with Anderson & Krathwohl (2001) stated that the purpose of learning was to cultivate the ability of retaining the same subject matter as the material being taught and the minimal cognitive processes was remembering. It was further mentioned, metacognitive knowledge was one of the knowledge was needed. Metacognitive "remembering" knowledge is essential as a preparation for meaningful learning and resolve problems, such knowledge is used in more complex tasks.

Peters (2000) stated that metacognitive skills help the students to be self-regulated learners learners, self-management and self-evaluation. The same thing also expressed by Eggen and Kauchak (1996) that metacognitive skills helped students more responsible for their own learning progress and adapting learning strategies to achieve the demands of the task. Implementation of the task demands needs the retention.

Retention was the amount of knowledge learned by the students could be stored in memory and could be revealed again in a certain time interval (Pranata, 2006). Memory was the information retention over time involving the storage, encoding, and recalling of information (Santrock, 2007). In line with the references above, the characteristic of Biology classroom that have been conducted shows that emphasize learning in metacognitive skills lead the students will more easily remember the learning materials within a certain period. Sumampouw (2011) argued that the retention could be increased through the metacognitive skills. Metacognitive skills were believed to play an important role in many types of cognitive activity includes understanding, communication, attention, retention, and problem solving (Howard, 2004).

The implementation of appropriate biology learning strategy will be effective to empower the students' retention. Retention measurement after learning process is important to monitor the developments of mastery learning. It aims to find out the ability of students to memorize the learning material that has been accepted. Slavin (2000) explained that someone could stored information in memory, not only the information relating to the facts, but also in the form of learning strategies to make it easier to be accessed again. Yeli (2007) explained that the memory associated with the experience would be stored on the memory containing facts, concepts, principles and rules for how to use it.

CONCLUSIONS

The research results showed that the correlations between metacognitive skills and students' retention were significant. The results of the analysis of variance related to the regression equation in the four different strategies were parallel and not coincide and the regression line of RQA strategy was at the highest position. It indicated that this strategy has the potency to empower metacognitive skills and simultaneously maintained the students' retention. It would be an important information for lecturers that they should empower the metacognitive skills through the appropriate learning strategies because it was believed could effected the students' retention.

REFERENCES

1. Anderson, O. W., & Krathwohl, D. R. (2001). A taxonomy for learning, teaching, and assessing (A revision of Bloom's taxonomy of educational objectives). New York: Addision Wesley Longman, Inc.
2. Atunasikha, L. (2010). Hubungan Keterampilan Metakognitif dan Pemahaman Konsep Siswa Laki-Laki dan Perempuan Kelas IV SDN Penanggungan Malang pada Pembelajaran SAINS dengan Strategi Pembelajaran PBMP dan Think Pain Share (TPS). Unpublished thesis. Malang: Universitas Negeri Malang, Indonesia.
3. Bahri, A. & Corebima, A. D. (2015). The contribution of learning motivation and metacognitive skills on cognitive learning outcome of students within different learning strategies. Journal of Baltic Science Education, 14 (4), 487-500.
4. Baran, M., & Maskan, A. K. (2011). A study of relationships between academic self concepts, some selected variables and physics course achievement. International Journal of Education, 3 (1), 1-12.
5. Coutinho, A. S. (2007). The relationship between goals, metacognition, and academic success. Educate Journal, 7 (1), 39-47.
6. Dahar, R. W. (1991). Teori-Teori Belajar [Learning Theories]. Jakarta, Indonesia: Erlangga.
7. Dawson, T. L. (2008). Metacognition and learning in adulthood. Prepared in response to tasking from ODNI/CHCO/IC leadership development office. Developmental Testing Service, LLC, Saturday, August 23, 2008. Retrieved from https://www.devtestservice.org/PDF/Metacognition.pdf.
8. Downing, K., Kwong, T., Chan, S. W., Lam, T. F., Downing, W. K. (2009). PBL and Development of Metacognition. High Education Journal, 57 (5), 609–621.
9. Dunning, D., Johnson, K., Ehrlinger, J., & Kruger, J. (2003). Why People Fail to Recognize Their Own Incompetence. Current Directions In Psychological Science, 12 (3), 83-87.
10. Eggen, P. D., & Kauchak, D. P. (1996). Strategies for Teachers. Boston: Elly and Bacon.
11. Ellis, G. (1999). Developing Metacognitive Awareness: The Missing Dimensio. (Online), Retrieved from http://www.britishcouncil.org/-developing-metacognitive-awareness.pdf.
12. Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. American Psychologist, 34 (10), 906–911. doi:10.1037/0003-066X.34.10.906.
13. Flavell, J. H. (1999). Cognitive development: children's knowledge about the mind. Annual Review of Psychology. 50 (1), 21-45. doi:10.1146/annurev.psych.50.1.21.
14. Hacker, D. J., Keener M. C., & Kircher J. C. (2009). Writing is applied metacognition. In Hacker D. J., Dunlosky J., Graesser A. C. (Eds.), Handbook of metacognition in education (pp. 154-172). New York: Routledge.
15. Hergenhahn, B. R. & Olson, M. H. (2009). Theories of learning. Translated by Tri Wibowo. Jakarta, Indonesia: Kencana.
16. Howard, J. B. (2004). Metacognitive inqury. North Carolina: School of Education, Elon University.
17. Kristiani, N., Susilo, H., & Corebima, A. D. (2015). The correlation between attitude toward science and cognitive learning result of students in different biology learnings. Journal of Baltic Science Education, 14 (6): 723-732.
18. Kuntjojo, & Matulessy, A. (2012). Hubungan antara metakognisi dan motivasi berprestasi dengan kreativitas [Correlation between metacognition and achievement motivation and creativity]. Jurnal Psikologi Persona, 1 (1), 1-18.
19. Kauchak, D.P. and Eggen, P.D. (2007). Learning and Teaching: Research-Based Methods. New York: Pearson Education, Inc.
20. Lee, M, and Baylor, A. L. (2006). Designing metacognitive maps for web-based learning. Educational Technology & Society. 9 (1), 344-348. (Online). Retrieved from http://www.ifets.info/journals/9_1/28.pdf.
21. McCormick, R. (2006). Learning how to learn: A view from the LHTL project England. in Learning learn network meeting report. Ispra: CRELL/JRC.
22. Muhiddin. (2012). Pengaruh integrasi PBL dengan pembelajaran kooperatif Jigsaw dan kemampuan akademik terhadap metakognisi, berpikir kritis, pemahaman konsep, dan retensi mahasiswa pada perkuliahan Biologi Dasar [Effect of PBL learning integrated with Cooperative Jigsaw and academic level on students' metacognition, critical thinking, concept comprehension, and retention in Basic Biology] (Unpublished doctoral dissertation)**.** The State University of Malang, Indonesia.
23. Mustaqim, S. B., Abdurrahman, & Viyanti. (2013). Pengaruh keterampilan **metakognitif** terhadap motivasi dan hasil belajar melalui model Problem-Based Learning [Effect of metacognitive skills on motivation and learning outcome through PBL]. Jurnal Pembelajaran Fisika (Journal of Learning Physics), 1 (5), 59-68.

24. O'Malley, J. M., & Chamot, A. U. (1990). Learning strategies in second language acquisition. Cambridge: Cambridge University Press.
25. Peters, M. (2000). Does Contructivist Epistemology Have a Place in Nurse Education. Journal of Nursing Education, 39(4), 166-170.
26. Pranata, M. (2006). Pengaruh Desain Pesan Multi-Media dan Tipe Literasi terhadap Kemampuan Retensi dan Transfer [Effect of Multimedia Message and Literacy Type towards Retention and Trasfer (Unpublished doctoral dissertation)**.** The State University of Malang, Indonesia.
27. Rahman, F. U., Jumani, N. B., Chaudry, M. A., Chisti, S. U. H., & Abbasi, F. (2010). Impact of metacognive awareness of performance of students in chemistry. Contemporary Issues in Education Research, 3 (10), 39-44.
28. Rahman, S., & Phillips, J.A. (2006). Hubungan antara Kesedaran Metakognisi, Motivasi dan Pencapaian Akademik Pelajar Universiti [Correlation between Metacognitive Awareness, Motivation, and Academic Achievement of University Students]. Jurnal Pendidikan, 31(1): 21 – 39.
29. Qualley, D.A., & Chiseri-Strater, E. (1994). Collaboration as Reflexive Dialogue: A Knowing Deeper Than Reason. Journal of Advanced Composition, 14(1), 111-130.
30. Salili, F., Chiu, C., & Lai, S. (2001). The influence of culture and context on students' motivational orientation and performance. In F. Salili, G. Ghiu, & Y. Hong (Eds.), Student motivation: The Culture and Context of Learning, (pp. 221–247). New York: Kluwer Academic/Plenumm.
31. Sanjaya, W. (2008). Strategi pembelajaran standar berorientasi standar proses (Standard learning strategy based on process standard). Jakarta, Indonesia: Kencana Predana Media Group.
32. Santrock, J. (2007). Child Development. New York. McGrow.
33. Schraw, G, Dennison R, S. (1994). Assessing metacognitive awareness. Contemporary Educational Psychology, 19 (4), 460-475.
34. Skaalvik, E. M., & Skaalvik, S. (2010). Teacher self-efficacy and teacher burnout: A study of relations. Journal of Teaching and Teacher Education, 26 (4), 1059-1069. doi:10.1016/j.tate.2009.11.001.
35. Slavin, R. E. (2006). Cooperative Learning: teori, riset dan praktik [Cooperative learning: theory, research & practic]. Translated by Narulta Yusron. Bandung, Indonesia: Nusa Media.
36. Slavin, R.E. (2000). Educational Psycology. Boston: Allyn and Bacon.
37. Sumampouw, H.M. (2011). Keterampilan Metakognitif dan Berpikir Tingkat Tinggi dalam Pembelajaran Genetika (Artikulasi Konsep dan Verifikasi Empiris) [Metacognitive Skills and High Order Thinking Skills in Genetic (Concept Articulation and Empirical Verivication)]. Jurnal Bioedukasi, 4(2), 23-39.
38. Uno, H. B. (2008). *Model Pembelajaran Menciptakan Proses Belajar yang Kreatif dan Efektif [Learning model to raise creatif and effective learning process]*. Jakarta, Indonesia: Bumi Aksara.
39. Yeli, S. (2007). Memori dan Pembelajaran [Memory and Learning]. Online Journal of FTK UIN Suska Riau. (Online). Retrieved from http://ftk.uin-suska.ac.id/attachments/article/15/salma-pem.pdf.
40. Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: an overview. Educational Psychologist, 25 (1), 3-17. doi:10.1207/s15326985ep2501_2.