The relationship between metacognitive skill and students’ cognitive learning outcomes using vee diagram-based learning in animal physiology module

S A Soesilawaty1,2,*, S Saefudin2, A R Wulan2 and A Adianto3
1Program Studi Pendidikan Ilmu Pengetahuan Alam, Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
2Program Studi Pendidikan Biologi, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
3Institut Teknologi Bandung, Jl. Ganesha No. 10, Bandung 40132, Indonesia

*soesyasiahsoesilawaty@gmail.com

Abstract. Metacognitive skill is acknowledged as one of the factors that can influence the cognitive learning. The link between metacognitive skill and cognitive learning outcomes can be investigated through the use of the specific instructional strategies. Thus, many previous studies had interested to scrutinise it. However, there has been little discussion on the relationship of metacognitive skill and cognitive learning outcome in learning Animal Physiology. This study is a correlational study that revealing the relationship metacognitive skill of student with the cognitive learning outcomes by Vee diagram as a learning strategy. The study was conducted for one semester. The population of this project was college student of Animal physiology FPMIPA UPI Bandung Indonesia, while the sample was single class that was taught by using Vee Diagram-based learning strategy. The findings highlight there is a relationship between metacognitive skill of college students with cognitive learning outcomes in the application of scientific learning. The regression equation based on the results of the data analysis is \( y = 0.493x + 20.37 \) with the reliability value of 0.529 which means the contribution of students’ metacognitive skill on the cognitive learning is 52.9%, while 47.1% are other factors beyond metacognitive skill. In conclusion, the findings of this study indicate that students’ metacognitive skill associated with the cognitive achievement in Vee-Diagram-based learning strategy in Animal Physiology module.

1. Introduction
Learning physiology, particularly for animal, requires a proper and a meaningful learning strategy. This due to the appropriate strategy can enhance the learning outcome. Learning strategy in biology literally is not the same with the other disciplines [1]. This because in Biology, students should be guided to “discover” the knowledge or information by themselves which eventually they would implement it in their daily life. In addition, biology is a part of science that is obtained by systematic steps or what it is called as scientific methodology [2]. Therefore, Vee Diagram-based learning is the one of many strategies that is proper to foster the metacognitive skill compares to others.
The Vee Diagram-based learning in biology not only could be able to improve the learning outcome, but also could flourish students’ metacognitive skill. This metacognitive discourse has been scrutinised in many previous research. Metacognitive has been acknowledged as a people’s knowledge about their cognitive system [3]. Based on the competency that has been stated in the current curriculum as a required skill that should be developed in the classroom activities. So that, the students should be able to apply their procedural and metacognitive knowledge in their daily learning activities. Some experts disclosed that metacognitive as “thinking about thinking” or knowing about knowing. Furthermore, metacognitive is an awareness and a management process and the product of people’s cognitive system out simply speaking it is called as “thinking about thinking” [4].

Additionally, the Vee Diagram concept could be employed as a strategy or instructional structure are able to improve students’ metacognitive skill. The previous study about the effectivity of Vee Diagram as a learning tool aimed students to comprehend the science concepts and make the learning more meaningful. Thus, Vee Diagram showed that is a worth tool for learning the structure and the process in learning to acquire the new knowledge, particularly the metacognitive [5]. Learning strategy using Vee Diagram has been proved proper and could be employed to foster students’ metacognitive skill.

Another discourses defines metacognitive as an awareness in thinking about the self-thinking process about what has been known or what will do [6]. For this reason, metacognitive involved the awareness to think and to act. This means that the metacognitive skill relates with the cognitive skill.

Previous studies showed that metacognitive skill could be spurred by using the proper learning strategy. This implies that metacognitive could be taught [7]. Another remarkable previous study also revealed that students who had been taught by metacognitive learning strategy have a better result/outcome and they are able to develop its forms into the higher level of thinking. Hence, metacognitive skill has a link with the students’ cognitive learning result. Promoting the metacognitive skill in the classroom will arouse to improve learning cognitive outcome. Thus, it is essential to take the students’ metacognitive skill as a granted. Moreover, it will be better to focus on the metacognitive of college students compare to the others, because the college students - particularly in the biology program - who have the skill, they will have an ability to maintain the learning process better than others. Those students could also be called as self-regulated learner, so their learning outcome could be managed due to their independency in thinking process (metacognitive).

Referring to the previous findings and the mentioned explanation above, the hypothesis of this study is “there is a positive correlation between metacognitive skill with the learning outcome of biology students in animal physiology learning by using Vee Diagram”. This implies that is needed to investigate the link between metacognitive skill with the cognitive learning outcome of biology students in animal physiology module. The aim of this study is to promote the other lecturers in considering the metacognitive strategy using Vee Diagram-based learning as a learning strategy in teaching physiology, particularly animal physiology.

2. Method
This inquiry is a correlational study that investigated the link between the metacognitive skills as a predictor with the cognitive learning outcome as a criterion. This project was administered for one semester. The population of this study is biology students who take the animal physiology module, yet the sample was chosen only one class who was taught by using the Vee Diagram-based learning. The data instrument that has been administered was essay and multiple-choice test which had been integrated with the cognitive learning outcome. These instruments had been validated before it is used.

The Hypothesis test started with a prerequisite test to know whether the data normally distributed. The normality test was performed using a one-sample test of Kolmogorov-Smirnov test. The normality criterion is if the significance value P > 0.05 then the data is normally distributing. While the homogeneity test was administered by using the Levene’s test – an equality test of error variant. The variable in assessing the homogeneity is if the significance value P > 0.05 then the data is categorised homogeneous. The data analysis of the correlation between metacognitive skill with the students’ cognitive learning outcome by using Vee Diagram was then tested by regression analysis.
3. Result and discussion
The study result was initiated with prerequisite test - normality and homogeneity test. Following then by the correlation test. The prerequisite test was administered first by using the Kolmogorov-Smirnov (Table 1) to test the normality of the data. Due to the data was considered has normal distribution, then it was continue tested by using Person-test (Table 2).and lastly it was also tested by the regression test (Table 3).

3.1. Prerequisite-test/ normality test
Table 1 shows that the Kolmogorov-Smirnov test results obtained the data as follow as: Metacognitive skill > 0.05 which means the data is normally distributed; the concept of > 0.05 means that data is normally distributed. Resulting from this, Pearson-test could be administered as the correlation test.

| Table 1. Normality test result/ Kolmogorov-Smirnova. |
|-----------------------------------------------------|
| Statistic df        Sig. | Statistic df        Sig. |
|----------------------|----------------------|
| Metacognitive skill  | .128                 | .130 | .925 | 37 | .016 |
| Concepts application | .110                 | .200*| .957 | 37 | .166 |
| a. Lilliefors Significance Correction                |

3.2. Pearson-test result
Table 2 portrays the value of correlation significance is 0.018 < 0. 05 means that the metacognitive skill and concept mastery have a positive and significant correlation at α = 0.05. Then, the final test was regression test that aims to investigate the direction of the relationship among the variables.

| Table 2. Pearson-test results. |
|---------------------------------|
| Metacognitive skill             | Concept mastery          |
| Pearson Correlation             | 1                        | .386*                   |
| Sig. (2-tailed)                 | .018                     |                         |
| N                               | 37                       | 37                      |
| Concept mastery                 | Pearson Correlation      | .386*                   |
| Sig. (2-tailed)                 | .018                     |                         |
| N                               | 37                       | 37                      |
| * Correlation is significant at the 0.05 level (2-tailed). |

3.3. Regression test result
Table 3 shows that R² = 0.149 means that the metacognitive contribution to the concept mastery is 14.9%.

| Table 3. Regression analysis results. |
|---------------------------------------|
| Metacognitive skill with concept mastery | R | R Squared | Eta | Eta Squared |
|-----------------------------------------|---|-----------|-----|-------------|
| .386                                    | .149 | .451   | .203 |

The findings of this study showed a positive correlation between metacognitive skills with cognitive learning outcome of students who were taught using Vee Diagram-based learning strategy. This relationship is indicated by the results of data analysis that has been portrayed by the regression line of relationship of metacognitive skills and cognitive learning outcomes in learning animal physiology based on Vee Diagram is significant. The data analysis also discloses a positive number on the regression coefficient value of the learning. This means that the higher the value of students' metacognitive skills, the higher the cognitive learning outcomes. The results of this study are in line with the results of the
The results of this study indicate that there is a contribution of metacognitive skills to the cognitive learning outcomes in animal physiology using Vee Diagram-based learning. This shows that promoting metacognitive skills can trigger the students to actively participate in Animal Physiology lectures to learn, plan their learning, control their learning, and evaluate the extent of their own ability as learners and reflect on their learning, including assess their weaknesses and strengths. The results of this study are in line with the previous study’s finding that reported a significant positive correlation between academic achievement with the use of self-regulated strategies in learning [10].

Furthermore, metacognitive activity could also be constructed in the form of task completion planning, monitoring the learning mastery, and evaluating progress which can actively control the cognitive processes of learners [9]. Therefore, for students who have high metacognitive skills can be guaranteed they have high cognitive learning outcomes too. The previous study supports this discourse revealing that the habituating students with metacognitive strategies can effectively develop metacognitive controls, so it can enhance the understanding of learners [11]. This understanding is an achievement that will be achieved by learners. Achievement of learning is the ability of learners as a result of learning activities and can be observed through the learning activities. The factors that may affect learning achievement are: (1) the factors that can be changed: (a) the way of teaching, (b) the quality of the design, (c) the evaluation model, and others, and (2) factors that must be accepted as they are: (a) student background, (b) intelligence, (c) salary, (d) learning style, (e) goal orientation, and so on. Furthermore, there are five types of learning outcomes: (1) verbal information, (2) intellectual skills, (3) cognitive strategies, (4) attitudes, (5) skills [12]. These five learning outcomes are influenced by factors that can be changed including learning strategies. Therefore, the development of metacognitive skills can be achieved through the use of learning strategies.

Metacognition refers to the awareness and monitoring of one's mind and task performance, or more simply, thinking about one's thinking [13]. It refers to the high level of mental processes involved in learning such as making plans for learning, using the right skills and strategies to solve problems, making performance estimates, and calibrating the level of learning. In addition, metacognition is important in learning and is a strong predictor of academic success [14]. Students with good metacognition will show good academic performance compared with low-learner metacognition. Learners with low metacognition may benefit from metacognitive training to improve metacognition and academic achievement. Thus, metacognition is related to student academic success so it is important to be empowered through learning. There is a significant influence on all dimensions of metacognitive skills with performance appraisal [15]. Moreover, metacognition was also construed as the ability to understand and monitor thoughts or minds all at once the assumptions and implications of one's activities [16]. Furthermore, metacognition can be concluded as an activity which reminds and controls one's cognition that may not be different from cognitive strategies [9].

The other replication showed that metacognition holds one of the most important roles for successful learning. This because metacognitive skills required learners to organize effective strategies for learning so that they’re avoided from learning disabilities. Metacognitive is associated with cognitive learning outcomes. Research shows that learners who are skilled in metacognitive cognitive learning outcomes are better than those who are not skilled in metacognitive [15,17]. The other evidence also shows that improving metacognition of learners can lead to improve learning outcomes. Thus, metacognition is an important component of intelligence and cognition as well as a major influence on academic success.

By showing a positive relationship between metacognitive skills with cognitive learning outcomes is not separated from the role of learning strategy with diagram Vee based. The Vee Diagram-based Learning Strategy reminds us of scientific method. The use of scientific method remains an iconic and long-lasting which is actively transforming teachers and learners to thinking about scientific practice [18]. Vee Diagram-based learning is a special way which helps us to organize our thoughts about the scientific process. Scenario of Vee Diagram based learning strategy begins with focus questions (focus question), object and ends with Knowledge claim (acquisitioning of new knowledge). It is named ‘Vee
diagram’ because this diagram is in the form of the letter "V" [19]. The shape and its parts can be seen in Figure 1. V form is not a requirement. The form of diagrams can also be modified into circular shapes or lines or any shapes [19]. Things that need to be highlighted are not on the shape, but how this diagram can provide a complex picture of the relationship between theory and practice (thinking and doing).

Vee diagram has conceptual (thinking) and methodological (work) sides. Both sides actively interact with each other during the use of focus or research questions (questions). The edge of Vee contains of the events or objects being observed. Both sides of diagram V emphasize two aspects of interdependent science learning, namely theory (thinking) and practice (doing). What students know at the time will determine the quality and quantity of questions they ask to. Instead the answers made to their questions will affect what they know by altering, adding, correcting and rearranging their knowledge [19]. Diagram V, looking at its parts, represents the theory of constructivism in the acquisition of knowledge. By following the process of the V diagram, a person will appropriately build his knowledge structure. Diagram V links to the development or discovery of knowledge of procedural activities undertaken in laboratories and theoretical concepts and ideas that lead to scientific inquiry [17]. This learning reflects a classical philosophical perspective rooted in falsifiability. This classical perspective has been expanded by contemporary philosophers of science, especially in the biology of Animal physiology. Therefore, the use of Vee Diagram based learning strategy can empower metacognitive skills while improving cognitive learning outcomes of learners.

4. Conclusion

Based on the results and discussion, it can be concluded that there is a positive relationship between metacognitive skills and cognitive learning outcomes of students participating in animal physiology module by using Vee diagram-based learning strategy. Given that, it is suggested and recommended to conduct similar research by using the recommended learning strategy in the implementation of Curriculum 2013, for instance in inquiry learning, problem-based-learning, project-based learning, and discovery learning instead of other learning strategies.

References

[1] Sabilu K 2010 Study On The Toxicity of Nickel to Oxygen Consumption, Haematological and Histopathological Condition and Secondary Stress of Juvenile Milkfish Chanos chanos [Forsskal] Juvenile
[2] Kristiani N 2009 Pengaruh Strategi Pembelajaran dan Kemampuan Akademik Serta Interaksinya Terhadap Kemampuan Metakognisi dan Hasil Belajar Kognitif Siswa Kelas X di SMA Negeri 9 Malang (Malang: Program Pascasarjana Universitas Negeri Malang)
[3] Flavell J H 1976 Metacognitive Aspect of Problem Solving. In L. B. Resnick (Ed.), The Nature of Intelligence (Hillsdale, NJ: Erlbaum Association)
[4] Kuhn D 2000 Theory Of Mind, Metacognition and Reasoning: A life span Perspective. In P. Mitchel & KJ Riggs Eds. Children’s Reasoning and The Mind pp 301-326 (Hove : UK Press)
[5] Alvarez M C Risko V J 2007 The Use of Vee Diagram with Third Graders As a Metacognitive Tool For Learning Science Concepts (Nashville: Tennessee State University)
[6] Moore D M and Dwyer F M 2001 The Relationship of Field Dependence and Color-coding to female students' achievement Perceptual and Motor Skills 93 pp 81-85
[7] Borich G 2007 Introduction to the thinking curriculum in On A and Borich (Eds) Teaching Strategies to Prounte Thinking (Singapore: McGrow-Hill)
[8] Efendi N 2013 Pengaruh Pembelajaran Reciprocal Teaching dipadukan Think Pair Share Terhadap Peningkatan Kemampuan Metakognitif Belajar Biologi Siswa SMA berkemampuan akademik berbeda di Kabupaten Sidoarjo Jurnal Santiaji Pendidikan 3(2)
[9] Livingston J A 1997 Metacognition: An Overview (Online) available at: http://www.gse.buffalo.edu/fas/shuel/cep564/metacog.html
[10] Camahalan F M G 2000 Effects of Self Regulated Learning on Mathematics Achievement of Selected Southeast Asian Children. Journal of Instructional Psychology 33(3) pp 194-205
[11] Amnah S 2009 Pengaruh Pembelajaran Kooperatif TPS, Jigsaw, Kombinasi dengan Strategi Metakognitif dan Kemampuan Akademik terhadap Kesadaran Metakognitif, Keterampilan Metakognitif, dan Hasil Belajar Kognitif Siswa di SMA Negeri Kota Pekan Baru Riau Disertasi tidak diterbitkan (Malang: PPS Universitas Negeri Malang)

[12] Tegeh I M and Kirna I M 2010 Metode Penelitian Pengembangan Pendidikan (Singaraja: Universitas Pendidikan Ganesha)

[13] Flavell J 1979 Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry American Psychologist 34 pp 301-326

[14] Dunning D Johnson K Ehrlinger J and Kruger J 2003 Why People Fail to Recognize their own Incompetence Current Directions in Psychological Science 12(3) pp 83-87

[15] O’Neil H F and Abed I J 1996 Reliability and Validity of a State Metacognitive Inventory: Potential for alternative Assessment Unpublished manuscript University of California

[16] Lin X 2001 Designing metacognitive activities Educational Technology Research and Development Research 33(2) pp 211-41

[17] Popper K R 1968 The Logic of Scientific Discovery. New York: Harper and Row

[18] Bencze J L and Bowen G M 2001 Learner-controlled projects in science teacher education: Planting seeds for revolutionary change Paper presented at the Annual Meeting of the American Educational Research Association, Seattle, WA

[19] Novak J D and Gowin D B 1984 Learning how to learn Cambridge University Press