Identification of preservice biology teachers’ metacognitive awareness and metacognitive skills

Astuti Muh. Amin1*, Romi Adiansyah2
1Biology Education Study Program – IAIN Ternate-North Maluku, Indonesia.
2Biology Education Study Program – MIPA – STKIP Muhammadiyah Bone, South Sulawesi, Indonesia

1*Corresponding author: astutimuhamin@iain-ternate.ac.id

Abstract. Metacognition can make a significant contribution to learning, especially that related to intellectual ability. Students’ metacognitive awareness and skills can be developed through consistent implementation of appropriate learning designs and students’ progress monitoring. The current research attempted to identify students’ metacognitive awareness and metacognitive skills in a biology education context. This research involved 142 preservice biology teachers from STKIP Pembangunan Indonesia Makassar, UIN Alauddin Makassar, Universitas Pejuang Republik Indonesia (UPRI) Makassar, and STKIP Yapim Maros. This study employed a descriptive quantitative method where metacognitive awareness inventory (MAI) was distributed to gather data on the participants’ metacognitive awareness and an essay test was conducted to examine the students’ metacognitive skills. The results show that the students’ metacognitive awareness falls into very low category with the average score of 37.55 for planning, 37.97 for monitoring, 38.39 for evaluating, and 35.73 for revising. Based on the test results, almost half of the students (44.90%) are categorized can not really; none of them (0%) were super or ok; 13.63% of the students fall into development category; 39.49% into risk category; and 1.97% into not yet category.

1. Introduction
Metacognition refers to cognitive monitoring or cognitive control activity [1, 2, 3, 4]. Metacognition can also be defined as knowledge of cognitive processes as well as how to use them to learn, remember, and understand something [5]. As a construction process, metacognition deals with someone’s awareness of mental processes in planning, controlling, and evaluating learning performance to achieve goals [6]. Thus, it can give a significant contribution to learning, especially that related to intellectual ability [7]. Learners who possess high metacognitive ability will be able to improve their self-esteem in order to attain their goals. They will become more aware of mistakes they make during the process and will attempt to reflect on them [8]. The capacity to think and use metacognitive ability is one of parameters to distinguish high achievers from slow learners [9]. Improved metacognition will result in promoting students’ awareness of successful learning process and strategies. Learners armed with this knowledge will be able to understand their own thoughts and learning, monitor their own performance, find solutions to every problem, and evaluate themselves [10, 11, 12, 13, 14].

There are two components of metacognition: (1) metacognitive awareness and (2) metacognitive skills. Metacognitive awareness is closely related to an individual’s declarative, procedural, and conditional knowledge of problem solving [15, 16], while metacognitive skills are generally associated
with predicting, planning, monitoring, and evaluating skill [17]. The relationship between cognition and metacognition is quite complex. Both of them are mutually bound so that it is difficult for someone to manage things related to metacognition without performing cognitive activities such as steps in solving a problem [18, 19, 20]. Metacognitive awareness is illustrated as: (a) conditional knowledge, a group of knowledge (information, skills, and things alike) which refers to a cognition. This knowledge allows someone to be informed about appropriate time (when), reason (why) and rationales to make a move or to use metacognitive strategies; (b) planning, is an act performed as a preparation before doing a cognitive activity. Planning includes making a right decision on what to do to achieve the activity goal. This activity can also help maximize the resources such as time and capability; (c) regulation is aimed to lead a cognitive activity in the right direction; (d) evaluation is the assessment of one’s ability in covering any cognitive tasks. The purpose of it is to measure the effectiveness of the use of all resources including the implementation of an effective meta-comprehension.

The development of students’ metacognitive skills highly depends on learning patterns applied in the classroom. In fact, some schools and universities are still comfortable with conventional learning methods or a certain learning strategy [21] which actually does not contribute much the the development of their students’ metacognitive skills. As a result, the students’ cognitive ability is less developed because they are not used to practicing their self assessment and self regulated skills [22]. Research findings by Keiichi [23, 24] suggest that: (a) metacognitive skills have a crucial role in problem solving; (b) metacognitive skills help students to improve other skills. On the other hand, Keiichi revealed that in the field, teachers/lecturers emphasize a certain problem solving strategy rather than paying more attention to the important features of the activities. It was also proven that the teachers/lecturers showed impressive achievement that is essential for reasoning and problem strategy posing.

There is a linear positive correlation between metacognitive awareness and metacognitive skills. Therefore, around 55,2% of learners’ metacognitive skills are influenced by their metacognitive awareness [25]. According to Schoenfeld [26], there are three keys to explaining metacognitive in biology learning. The first one is trust and intuition. Trust and intuition are often associated with biology ideas that are prepared to solve a biology problem. Second is knowledge of thinking process which can help an individual to express his thoughts. Meanwhile, self awareness or self regulated skills are more useful in determining what actions to take to solve a problem and to what extent someone can use observation results to direct the process. These skills are essential; thus, every individual including a lecturer and a (preservice/inservice) teacher needs to possess them.

The empowerment of students’ metacognitive skills will yield the best results when teachers/lecturers are able to consistently implement appropriate learning designs and monitor students’ progress. An accountable learning can occur if teachers/lecturers base their decision in choosing an appropriate learning method on the students’ needs. This type of learning is assumed to be effective in improving students’ metacognitive skills [21]. Learners who learn to solve a problem will apply their background knowledge or attempt to seek for new knowledge when necessary. They will obtain learning experiences which allow them to use a scientific method to approach problems. Through this way, their metacognitive awareness and metacognitive skills can be stimulated.

Animal Physiology is a compulsory subject for the students of biology education program. This course provides students with a deep understanding of concepts and principles of animals physiological processes as well as the implementation of the concepts and the principles in various scientific contexts. Therefore, university courses need to accommodate students’ thinking structure including metacognitive awareness and metacognitive skills in order that goals can be achieved. However, learning patterns which have been implemented are not yet able to help students to attain these goals. Previous research findings [27] have reported low students’ mastery (42,35) of Animal Physiology concepts. Meanwhile, in relation to the learning methods, classroom activities were dominated by lectures (58,13%), discussions (18,47%), questions and answers sessions (21,37%), demonstrations (1,89%), assignments (13,96%), experiments (11,72%), and others (2,63%). The
results of the research also showed that the students’ critical thinking skills were not well developed. According to the analysis, the students’ critical thinking skills were categorized low (2,11) [28].

For those reasons, the current research attempted to identify biology education students’ metacognitive awareness and metacognitive skills. It is expected that the results of this study can provide information for lecturers about the empowerment of university students’ metacognitive skills which will result in producing more qualified graduates who are able to meet the 21st century learning demands.

2. Research Method
This study employed a descriptive quantitative method. A questionnaire and a metacognitive skills test were used to collect the data. Research subjects involved 142 preservice biology teachers from four universities, namely STKIP Pembangunan Indonesia Makassar (38 students), UIN Alauddin Makassar (33 students), Universitas Pejuang Republik Indonesia (UPRI) Makassar (38 students), STKIP Yapim Maros (33 students). The present research was conducted from December 2015 to June 2016. Instruments used in this study were the metacognitive awareness inventory (MAI) and an essay test which had been validated by the experts.

Metacognitive awareness inventory (MAI) was employed to measure students’ metacognitive awareness. This questionnaire was adapted from Schraw & Dennison [29]. It consisted of two parts: metacognition knowledge and metacognition regulation. Metacognitive knowledge covers (1) declarative knowledge, (2) procedural knowledge; (3) conditional knowledge while metacognition regulation includes: (1) planning, (2) information management strategy, (3) comprehension monitoring, (4) correction strategy, and (5) evaluation. The two components were distributed into 52 items with four scales (strongly agree, agree, disagree, strongly disagree). The scales were weighed 1 for strongly disagree to 4 for strongly agree.

The students’ metacognitive skills were measured by an essay test which had been validated beforehand. A metacognitive skills rubric was used to determine the students’ score which consisted of 7 scales (0-7). The rubric was also used as a reference to check whether all the items had been answered. Students’ metacognitive skills would be determined based on whether the answer was written: (1) in the students’ own sentence, (2) in a coherent, systematic, and logic, (3) in a good grammar or language, (4) in an evaluative or creative way, (5) in a proper way (correct/incorrect/not answered) [30]. Scores on the rubric were calculated using the following formula [31]:

$$\frac{y_1+2x}{3} = y_2$$  

(1)

Notes:
- $y_1$ = concept understanding
- $y_2$ = concept understanding and metacognitive skills
- $x$ = metacognitive skills

Referring to [32], students’ scores on metacognitive skills were thus categorized into super (85-100), ok (68-84), development (51-67), cannot really (34-50), risk (17-33), and not yet (0-16).

3. Results and Discussion

3.1. Metacognitive Awareness
Metacognitive awareness of the preservice biology teachers who came from STKIP Pembangunan Indonesia (PI) Makassar, UIN Alauddin Makassar, UPRI Makassar, STKIP Yapim Maros is presented in Table 1.
### Table 1. Preservice Biology Teachers’ Metacognitive Awareness

| Indicator | STKIP PEMBANGUNAN INDONESIA (PI) MAKASSAR | UIN ALAUDDIN MAKASSAR | UPRI MAKASSAR | STKIP YAPIM MAROS | Average Score |
|-----------|------------------------------------------|-----------------------|---------------|-------------------|---------------|
| Planning  | 35.80                                    | 41.89                 | 33.16         | 39.33             | 37.55         |
| Monitoring| 35.98                                    | 40.94                 | 35.28         | 39.67             | 37.97         |
| Evaluating| 36.08                                    | 42.49                 | 36.14         | 38.86             | 38.39         |
| Revising  | 34.32                                    | 39.03                 | 32.84         | 36.73             | 35.73         |

As suggested by Table 1, the preservice biology teachers achieved highest in evaluating (38.39), followed by monitoring (37.97), planning (37.55), and revising (35.73). The figures indicated that the students’ metacognitive awareness was not yet fully developed. Metacognitive awareness varies from person to person depending on their background knowledge and learning experiences. Students’ metacognitive awareness can be trained. Therefore, lecturers are required to empower students’ thinking process, evaluate students’ progress and achievement. Other contributing factors to the development of students’ metacognitive awareness include learning facilities, independent tasks, laboratory activity, students’ interaction, and journal writing habit.

Students’ cognitive differences also determine the students’ varied learning needs and styles. Students’ cognitive ability can also influence their learning process. Metacognitive awareness is believed to play a crucial role in how students regulate their thinking process, learning process, and learning product generation [33, 34, 35]. Students’ high metacognitive awareness can help them improve their cognitive ability [36].

According to Afifi [37], there is a significant correlation between metacognitive awareness and metacognitive skills (0.492). Students’ metacognitive skills are affected by their metacognitive awareness by 24% while the rest (76%) involves other factors. Metacognitive awareness assists students to increase their ability to choose appropriate learning styles, proper problem solving strategies, and correct methods to evaluate learning. The development of students’ metacognitive awareness will result in increasing their cognitive ability [38, 39]. Students who are capable of functioning their metacognitive awareness are more likely to succeed in learning because their cognitive activities are well managed [40].

### 3.2. Metacognitive Skills

Metacognitive skills of the preservice biology teachers who came from STKIP Pembangunan Indonesia (PI) Makassar, UIN Alauddin Makassar, UPRI Makassar, STKIP Yapim Maros are summarized in Table 2.

### Table 2. Preservice Biology Teachers’ Scores on Metacognitive Skills

| Indicator                      | STKIP PEMBANGUNAN INDONESIA (PI) MAKASSAR | UIN ALAUDDIN MAKASSAR | UPRI MAKASSAR | STKIP YAPIM MAROS | Average |
|--------------------------------|------------------------------------------|-----------------------|---------------|-------------------|---------|
| The highest score              | 47.71                                    | 61.90                 | 53.90         | 54.29             | 54.45   |
| The lowest score               | 17.14                                    | 17.14                 | 23.24         | 23.81             | 20.33   |
| Range                          | 30.57                                    | 44.76                 | 30.66         | 30.48             | 34.11   |
| Average (risk)                 | 26.10                                    | 39.94                 | 39.70         | 38.09             | 35.96   |

Table 2 indicates that the average score of the students’ metacognitive skills is 35.96 (cannot really). In details, it falls into some categories shown in Table 3.
Table 3. Categories of Preservice Biology Teachers’ Metacognitive Skills

| Category          | Range of the Score Average | University         | Average |
|-------------------|---------------------------|-------------------|---------|
|                   |                           | STKIP PEMBANGUNAN INDEONESIA MAKASSAR (%) | UIN ALAUDDIN MAKASSAR (%) | UPRI MAKASSAR (%) | STKIP YAPIM MAROS (%) |
| Super             | 85-100                    | 0                 | 0       | 0       | 0       |
| Ok                | 68-84                     | 0                 | 0       | 0       | 0       |
| Development       | 51-67                     | 0                 | 27,27   | 0       | 27,27   | 13,63 |
| Can Not Really    | 34-50                     | 18,42             | 42,43   | 76,32   | 42,43   | 44,90 |
| Risk              | 17-33                     | 73,68             | 30,30   | 23,68   | 30,30   | 39,49 |
| Not Yet           | 0-16                      | 7,90              | 0       | 0       | 0       | 1,97  |

Table 3 shows that the majority of the students’ scores fall into cannot really category (44,90%) and risk category (39,49%). None of the students achieved super and ok scores (0%) and only a few students can be categorized as having developed metacognitive skills (13,63%). Preservice biology teachers need metacognitive skills to design learning and choose learning strategy or model to apply in the classroom [41]. The use of a particular learning strategy or model can result in affecting students’ metacognitive skills achievement [42]. Therefore, appropriate learning strategy or model can help learners develop their metacognitive control [40].

The key to developing individual’s metacognitive skills is to enhance his ability to monitor himself and his learning ability [43]. The empowerment of thinking skills and metacognition in learning is essential for an independent learner to be able to control his learning process and as a result achieve his learning goals [31]. Low metacognitive skills only result in students’ inability to develop their cognitive ability [44]. An individual with well developed metacognitive skills is better at solving problems, making decisions, thinking critically. She/he is also more motivated to learn, able to control emotions and able to deal with many difficulties [45].

Making a list of questions and answers is one of the strategies that can be applied to develop metacognitive skills. Other thing that may help includes making a summary or a mind map based on learned materials [46]. Learners must be able to develop their metacognitive skills by implementing learning strategies that suit their characters and habits. Biology lecturers, thus, are required to assist students to use metacognitive strategies to improve their metacognitive awareness and learning achievement [47]. Metacognitive skills are needed by the students to understand how to perform the task [48].

4. Conclusion
Based on the results of the present research, the students’ metacognitive awareness falls into very low category with the average score of 37,55 for planning, 37,97 for monitoring, 38,39 for evaluating, and 35,73 for revising. Based on the test results, almost half of the students (44,90%) are categorized into cannot really; none of them (0%) were super or ok; 13,63% of the students fall into development category; 39,49% into risk category; and 1,97% into not yet category.

5. Acknowledgement
We would like to thank Ibu Jamilah, S.Si., M.Si as the Head of Biology Department of UIN Makassar; Ibu Etty Rosmiati S.Pd., M.Pd as the Head of Mathematics and Natural Sciences Department of FKIP UPRI Makassar; Ibu Eka Aprilia, M.Pd as the Head of Biology Education Study Program of STKIP PI Makassar; The Head of Biology Education Study Program of STKIP Yapim Makassar for facilitating meetings with fellow biology lecturer. Our gratitude also goes to the team that has helped us with data recapitulation.
References

[1] Young, A & Fry, J.D. Metacognitive Awareness and Academic Achievement in College Students. Journal of the Scholarship of Teaching and Learning, 8 (2): 1-10.

[2] Kozikoglu, I. 2019. Investigating Critical Thinking in Prospective Teachers: Metacognitive Skills, Problem Solving Skills and Academic Self-Efficacy. Journal of Social Studies Education Research, 10(2) 111-130

[3] Livingston, J. A. 1997. Metacognition: An Overview.(online) http://www. gse. buffalo. edu/fas/shuell/CEP564. Metacog. Html.

[4] Shida, N, Sharifah, Hanifah, Norulhuda, & Halim, A. 2019. The Influence of E-Learning towards Metacognitive Enhancement in Mathematical Problem Solving. iJET, 14(20), 165-173. https://doi.org/10.3991/ijet.v14i20.11466

[5] Ormord, J.E. 2004. Human Learning. Upper Saddle River. NJ: Pearson Prentice Hall.

[6] Rahimi, M., & Kotal, M. 2012. Metacognitive Strategies Awareness and Success in Learning English as a Foreign Language: an Overview. Procedia-Social and Behavioral Sciences, 31: 73-81.

[7] Veenman, M. V. J., Wilhelm, P., & Beishuizen, J. J. 2004. The Relation between Intellectual and Metacognitive Skills from a Developmental Perspective. Learning and Instruction, 14: 89-109.

[8] Senemoglu, N. 2012. Gelisim, Ogrenme Ve Ogretim. Ankara: Pegem Akademi Yayincilik.

[9] Curwen, M. S., Roxanne, G. M., Kimberly, A., White-Smith, & Robert, C.C. 2010. Increasing Teachers’ Metacognition Develops Students’ Higher Learning during Content Area Literacy Instruction: Finding from the Read-Write Cycle Project. Issues in Teacher Education, 19(2): 157-151.

[10] Zhang, D., & Goh, C. 2006. Strategy Knowledge and Perceived Strategy Use: Singaporean Students’ Awareness of Listening and Speaking Strategies. Language Awareness, 15: 199-219.

[11] Brown, A. L., dan DeLoache, J. S. 1978. Skills, Plans, and Self-Regulation. In R. S. Siegel (ed.), Childrens Thinking: What Develops. Hillsdale, N. J. Erlbaum.

[12] Veenman, M. V. J. 2006. Metacognition and learning: Conceptual and Methodological Considerations. Business Media, Inc, (online) www://springerlink.com, diakses pada tanggal 21 Januari 2018.

[13] Moore, B.N., & Parker, R. 1986. Critical Thinking. Los Angeles, CA: Mayfield.

[14] Ijirana, & Supriadi. 2018. Metacognitive skill profiles of chemistry education students in solving problem at low ability level. Jurnal Pendidikan IPA Indonesia, 7(2), 239-245. doi: 10.15294/jpии.v7i2.14266

[15] Ijirana, Nadjamuddin, L. 2019. Time Series Study of Probole Solving Ability of Tadulako University Students Metacognitive Skill Based Learning Model. iJET, 14(21), 227-234. https://doi.org/10.3991/ijet.v14i21.11684.

[16] Ramadhanti, D., Ghazali, S.A, Hasanah, M, & Harsiati, T. 2019. Students’Metacognitive Weaknesses in Academic Writing: A Preliminary Research. iJET, 14(11), 41-47.

[17] Yuberti. 2019. Approaching Problem-Solving Skills of Momentum and Impulse Phenomena Using Context and Problem-Based Learning. European Journal of Educational Research, 4(8) 1712-1227.

[18] Veenman, M. V., Van Hout-Wolters, B. H., & Afflerbach, P. 2006. Metacognition and Learning: Conceptual and Methodological Considerations. Metacognition and Learning, 1(1): 3-14.

[19] Mohammad Haron. 1998. Keupayaan Metapemahaman dalam Pembacaan dan Pendengaran Di Kalangan Pelajar Tingkat Empat. Tesis tidak diterbitkan, Fakultas Pendidikan, Universiti Malaya, Kuala Lumpur.

[20] Corebima, A.D. 2016. Pembelajaran Biologi di Indonesia Bukan untuk Hidup. Proceeding Biology Education Conference, diselenggaraan oleh FKIP UNS, 6 Agustus 2016. Surakarta:
Universitas Sebelas Maret.

[21] Bahri, A. 2010. Pengaruh Strategi Problem-Based Learning (PBL) Terintegrasi Reading Questioning and Answering (RQA) pada Perkuliahan Biologi Dasar terhadap Motivasi Belajar, Keterampilan Metakognitif, Hasil Belajar Kognitif, Retensi dan Karakter Mahasiswa Berkemampuan Akademik Berbeda. Disertasi tidak diterbitkan. Malang: PPs UMM.

[22] Hogan, M. J., Dwyer, C. P., Harney, O. M., Noone, C., & Conway, R. J. 2015. Metacognitive skill development and applied systems science: A framework of metacognitive skills, self-regulatory functions and real-world applications. In Metacognition: Fundaments, applications, and trends (pp. 75–106). Springer.

[23] Sugiaro, B. dan Sophianingtyas, F. 2013. Identifikasi Level Metakognitif Siswa dalam Memecahkan Masalah Materi Perhitungan Kimia [Identifying Students’ metacognitive Skill Level in solving Chemical Computation Problems]. UNESA. Journal of Chemical Education, 2(1): 21-27.

[24] Keiichi, S. 2000. Metacognition in Mathematics Education. Mathematics Educations in Japan. Japan: JSME, July 2000.

[25] Amin, I & Sukestiyarno, Y.L. 2015. Analysis Metacognitive Skills on Learning Mathematics in High School. International Journal of Education and Research, 3 (3): 213-222.

[26] Schoenfeld, A.H. 1992. Learning to Think Mathematically: Problem Solving, Metacognition, & Sensse-Making In Mathematics. Handbook for Research on Mathematics Teaching and Learning. In D. Grouws (Ed). New York: MacMillan.

[27] Amin, A. M., Corebima, A.D., Zubaidah, S., & Mahanal, S. 2020. The Correlation between Metacognitive Skills and Critical Thinking Skills at the Implementation of Four Different Learning Strategies in Animal Physiology Lectures. European Journal of Educational Research, 9(1),143-163.https://doi.org/10.12973/eu-jer.9.1.143

[28] Amin, A.M., Corebima, A.D., Zubaidah, S., Mahanal, S. 2016. Analisis Penguasaan Konsep dan Metode Pembelajaran dalam Pembelajaran Calon Guru Biologi di Kota Makassar. Prosiding Seminar Nasional ke-3 Biologi, IPA, dan Pembelajarannya Universitas Negeri Malang, 15 Oktober 2016.

[29] Amin, A.M., Corebima, A.D., Zubaidah, S., Mahanal, S. 2017. The Critical Thinking Skills Profile of Preservice Biology Teachers in Animal Physiology. Advances in Social Science Education and Humanities Research, 128, 179-183.

[30] Schraw, G., & Dennison, R.S. 1994. Assessing Metacognitive Awareness. Contemporory Educational Psychology. University of Nebraska of Lincoln

[31] Corebima, AD. 2009. Metacognitive Skill Measurement Integrated in Achievement Test. Paper was presented on 3rd International Conference on Science and Mathematics Education. Penang: 10-12 November 2009.

[32] Green, R. 2002. Better Thinking Learning an Introduction to Cognitive Education. Western Cape Education Department, (Online), http:// curriculum.pgwe.gov.za/curr_dev/cur_home/better_think/index.htm. Diakses pada tanggal 21 Januari 2018.

[33] Hartman, H. J. 1998. Metacognition in Teaching and Learning: an Introduction. Instructional Science – International Journal of Learning and Cognition, 26: 1–3.

[34] Erlin, E., & Fitriani, A. 2018. Profile metacognitive awareness of biology education students in microbiology course. Journal of Physics: Conf. Series 1157, 0222066, 1-5. doi:10.1088/1742-6596/1157/2/022066.

[35] Pantiwati, Y., & Husamah 2017. Self and Peer Assessments in Active Learning Model to Increase Metacognitive Awareness and Cognitive Abilities. International Journal of Instruction, 10(4), 185-202. https://doi.org/10.12973/iji.2017.10411a

[36] Fouche, J., & Lamport, M. A. 2011. Do Metacognitive Strategies Improve Student Achievement in Secondary Science Classrooms?. Christian Perspectives in Education, 4(2): 1-25.
Amin, AM., & Adiansyah, R. 2018. *Identifikasi Gaya Belajar dan Respon Mahasiswa untuk Menentukan Strategi Belajar pada Perkuliahan Fisiologi Hewan [Identifying Students’ Learning Styles and their Responses to determine Learning Strategies in Animal Physiology Lecture]*. *Jurnal Biologi & Pembelajaran*, 5(1), pp. 1-9.

Affi., R., Hindriana, A.F., Soestisna, U. 2016. *Korelasi Kesadaran & Keterampilan Metakognitif Mahasiswa Calon Guru Biologi dalam Pembelajaran Project Based Learning Berbasis Praktikum. Jurnal Pendidikan Biologi*, 4 (1): 10-18.

Wicaksono, A.G.C. 2016. *Perbandingan Kemampuan Kognitif & Metakognitif Mahasiswa dengan Gaya Belajar yang Berbeda. Media Penelitian Pendidikan*, 10 (2): 142-153.

Livingston, J.A. 1997. *Metacognition: An Overview. http://www.ttuhsc.edu/sop/faculty/compass/Definition of METACOGNITION.pdf*. Diakses pada tanggal 21 Januari 2018.

Muhsin, A., Susilo, H., Amin, M., Rohman, F. 2016. *Analisis Keterampilan Metakognitif Diinjaw dari Kemampuan Akademik Berbeda pada Perkuliahan Konsep Dasar IPA*. Prosiding Seminar Nasional Biologi 2016 Universitas Negeri Surabaya.

Caliskan, M., & Sunbul, A. 2011. *The Effects of Learning Strategies Instruction on Metacognitive Knowledge, Using Metacognitive Skills and Academic Achievement (Primary Education Sixth Grade Turkish Course Sample). Educational Sciences: Theory&Practice*, 11 (1): 148-153.

Charleroy, A., Gentry, C., Greco, A., Rubino, N., & Schatz, M. 2011. *Arts Education Standards and 21st Century Skills, An Analysis of the National Standards for Education (1994), As Compared to the 21st Century Skills Map for the Arts*. New York, NY: The College Board Office of Academic Initiatives 45 Columbus Avenue 10023-6992.

Putri, N. 2013. *Pengaruh Strategi Pembelajaran (PBL dan RT) terhadap Keterampilan Metakognitif, Hasil belajar Biologi, dan Retensi Siswa Berkemampuan Akademik Rendah Kelas X pada SMA yang Berbeda. Jurnal. (Online), (jurnalonline.um.ac.id)/. Diakses pada tanggal 21 Januari 2018

Dawson, T.L. 2008. *Metacognition and Learning in Adulthood. ODNI/CHCO/IC Leadership Development*. Northampton, 23 Agustus.

Slavin, Robert E. 1994. *Educational Psychology. (4th ed.). USA: Allyn and Bacon*

Amnah, S. 2014. *Profil Kesadaran & Strategi Metakognisi Mahasiswa Baru Pendidikan Biologi Fakultas Keguruan & Ilmu Pendidikan Universitas Islam Riau Pekan Baru. Jurnal Pendidikan IPA Indonesia*, 3 (1): 22-27.

Rivers, W. Summer. 2001. *Autonomy at All Cosis. An Ethnography of Metacognitive Self-Assessment and Self-Management among Experienced Language Learners. Modern Language Journal*, 86 (2): 279-290.