Research Article

Self-Assessed Metacognitive Awareness among Students of the University of Ibadan, Nigeria

Chiaka I. Anumudu[1]*

Adewale Adebayo[1]

Aanu Gboyega-Tokunbo[1]

Henrietta Awobode[1]

Raphael D. Isokpehi[2]

[1] Department of Zoology, University of Ibadan, Ibadan, Nigeria
[2] Department of Natural Sciences, College of Science Engineering and Mathematics, Bethune Cookman University, Florida, USA
**Corresponding Author*

Doi: 10.2478/jesr-2019-0036

Abstract

Metacognition consists of knowledge of cognition (metacognitive knowledge) and regulation of cognition (metacognitive regulatory skills). The growing emphasis on student/learner-centered teaching at various educational levels including universities has led to recommendations for increased use of metacognitive strategies in traditional classrooms and online classrooms. This study examined metacognitive awareness among university students. The study population included 210 undergraduates and postgraduates studying biology or genetics among their regular courses in the university. Participants provided responses to the 52-item Metacognitive Awareness Inventory (MAI) instrument that captures self-assessed level of agreement to items assessing metacognitive knowledge and metacognitive regulatory skills. We conducted statistical analysis on the data collected. Mean self-assessed MAI scores was 79.9% (41.6/52), with metacognitive regulation scores of 80.1% (28.0/35) higher than metacognitive knowledge. Metacognitive awareness tends to decrease with level of study. Metacognitive regulation associated significantly with level of study (p=0.0127) or level of study and field of biology together (p=0.005). Students think highly of their metacognitive awareness especially in the regulation of cognition and this self-belief tended to reduce with year of study. The results provide baseline for future studies and global comparisons.

Keywords: *self-assessed metacognition, Nigerian education system, biology, study skills*

1. Introduction

Metacognition serves as the operating mechanism of learning (Clark and Harrelson, 2002) and consists of two main components: knowledge of cognition and regulation of cognition (Schraw and Dennison, 1994; Schraw, 1998; Akin et al., 2007). The Metacognitive Awareness Inventory (MAI) instrument measures metacognitive knowledge (declarative knowledge, procedural knowledge, and conditional knowledge) and metacognitive regulatory skills (planning, information management strategies; monitoring, debugging strategies, and evaluation of learning) (Schraw and Dennison, 1994; Young and Fry, 2008). The inclusion of instruction on the metacognition subcomponents in the teaching of learning domains such as science, humanities and mathematics have benefits in learner academic achievements at secondary and post-secondary education (Azevedo, 2009; de Boer et al., 2018; Young and Worrell, 2018)

The growing emphasis on student/learner-centered teaching at various educational levels including universities has led to recommendations for increased use of metacognitive strategies in traditional classrooms and online classrooms (Kistner et al., 2010; Abdellah, 2015; Kohen and Kramarski, 2018). Furthermore, teaching strategies that incorporate instruction on metacognition are value-added strategies by inducing students to reflect on the basis and the process of their learning experiences in addition to the norm of solving problems and engagement in learning (Ellis et al., 2014; Avargil et al., 2018). Essentially, metacognition has a focus on the active participation of an individual in his or her learning process.

In Nigeria, promoting student metacognitive knowledge and metacognitive regulatory skills is part of the recommendations for improving the declining performance in secondary level public examinations in Nigeria (Okoza et al. 2013; Ijiga, 2014; Maduabuchi et al., 2016; Gengle et al., 2017). The metacognitive strategy of concept mapping lowered anxiety level towards the study of biology (Alaiyemola et al. 1990). Other metacognitive strategies proposed for use in the Nigerian school system are graphic organizers; metacognitive scaffolding; reciprocal teaching; explicit instruction; and collaborative learning (Okoza and Aluede, 2014). Thus, at the post-secondary level in Nigeria, explicit instruction on metacognition would help improve the metacognitive knowledge and metacognitive regulatory skills that learners exhibit during post-secondary learning and life-long learning. Studies on metacognition and learning in Nigeria have been limited with emphasis on secondary students (Nbina and Viko, 2010; Adedipe and Ofodu, 2011; Onu et al. 2012; Eluemuno et al., 2013; Okoza et al., 2013; Ijiga, 2014; Ajaja and Agboro-Eravwoke, 2017).

The Metacognitive Awareness Inventory (MAI) originally developed by Schraw and Dennison (1994) has been widely used to evaluate self-awareness of metacognition with various modifications by researchers. The use of MAI has been validated and found to be generally reliable (Jain et al, 2017). We have collected and analyzed self-assessed data on metacognitive knowledge and metacognitive regulatory skills of students studying biology or genetics among their regular courses at the University of Ibadan, Nigeria. The findings provide data to guide further research on appropriate instructional strategies for promoting metacognition for students at the University of Ibadan. The results provide a baseline for future studies and global comparisons.

2. Methods

2.1 Ethics statement and participants

Ethical approval was obtained from the University of Ibadan Social Research Ethics committee and written informed consent was obtained from participants. The study population included 210 undergraduates and postgraduates studying biology or genetics among their regular courses in the university. These were generally students in biology-related programmes such as Biochemistry, Microbiology, Zoology, Nursing, Agricultural Sciences, Physiology, Medicine and Surgery, Pharmacy.

2.2 Self-assessment of metacognitive awareness

Respondents were asked to fill a self-assessment questionnaire based on the 52-item Metacognitive Awareness Inventory (MAI) (Schraw and Dennison, 1994). The items of the scale were categorized under two main factors and 8 sub-factors. The main factors were knowledge about cognition (metacognitive knowledge) and regulation of cognition (metacognitive regulation/organization). In metacognitive knowledge, three sub-levels were listed: procedural knowledge (4 items); declarative knowledge (8 items) and conditional knowledge (5 items). Metacognitive regulation included five sub-factors: planning (7 items); information management (9 items); monitoring (8 items); debugging (5 items) and evaluation (6 items). For each item, students were asked to score themselves 0 for a 'False' answer and 1 for a 'True' answer. This was used as a self-assessed score on metacognition. Cronbach's alpha was used as a reliability test.

2.3 Data Analysis

Means and standard deviation of raw scores were used to describe the data. The percentage score of each respondent in each of the 8 sub-factors of metacognitive awareness inventory were also used to describe the data. Data did not appear to follow a standard normal distribution (Shapiro-Wilk test $p<0.0001$) and missing values were removed. In order to examine the relationship between the student's self-assessed scores for metacognitive awareness and the level of study or field of biology, percentage scores for the sub-factors of metacognitive awareness were calculated. Percentages were deemed better because actual mean scores and maximum scores were naturally different for each sub-factor. Kruskal Wallis and Multiple Analysis of Variance and multiple linear regression were used to examine differences between level of study or field of biology and percentage scores for each sub-factor, and between level of study or field of biology and percentage scores for multiple sub-factors. The significance level was set at $p<0.05$.

3. Results

3.1 Study participants in metacognitive awareness study at the University of Ibadan

A total of 210 students responded and their categories are indicated in Table 1. The respondents were students in biology-related programmes including Microbiology, Zoology, Botany, Medicine, Biochemistry, Physiology, Physiotherapy, Veterinary Medicine, Pharmacy, Human Nutrition, Aquaculture and Fisheries, Agriculture, Animal Science. For ease of analysis based on considerable sub-sample sizes, the departments were categorized into three fields of biology: (1) Natural Biological Sciences (Botany, Microbiology and Zoology), (2) Medical Sciences (Medicine, Biochemistry, Physiology, Physiotherapy, Veterinary medicine, Pharmacy, Human Nutrition) and Agricultural Sciences (Aquaculture and Fisheries, Agriculture, Animal Science).
There were four levels of study (first year, second year, third year and seniors) indicating number of years since admission into the university.

Table 1: Study participants in metacognitive awareness study at the University of Ibadan, Nigeria

Level of study	Number of Participants	Percentage of Participants
First year undergraduate	89	42.4
Second year undergraduate	55	26.2
Third year undergraduate	22	10.5
Senior	43	20.5
Total	210	
Field of biology		
Natural Biosciences	81	38.6
Medical Sciences	87	41.4
Agricultural Sciences	42	20.0
Total	210	

3.2 Overall metacognitive awareness

Overall scores were generally high across levels and fields of study (Figure 1, Figure 1b, Table 2). Cronbach's alpha for reliability of the coded data was 0.76. The respondents, on average, scored themselves higher than 77% of the maximum points available in each of the sub-factors of metacognitive awareness (Table 2). Scores tended to be marginally higher in first year undergrads than other categories, and in agricultural sciences students than other categories (Figure 1 and Figure 1b).

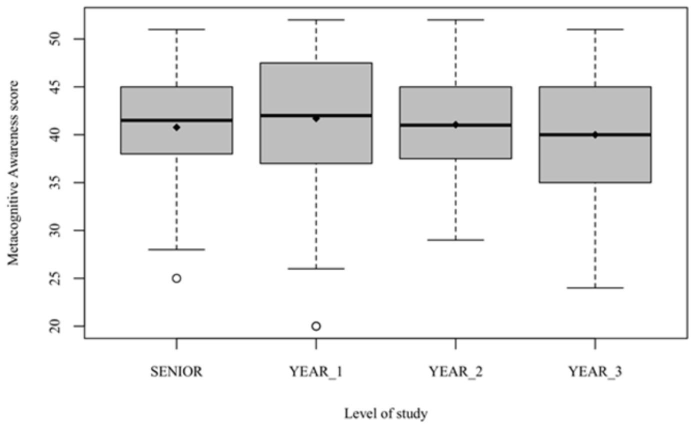

Figure 1: Self-assessed metacognitive awareness scores for various levels of students in biology-related programmes at University of Ibadan, Nigeria. Boxplots were drawn from the mean of raw scores for each item in questionnaire as assessed by respondents. Black points indicate overall mean, horizontal bars indicate median, circles indicate outliers.

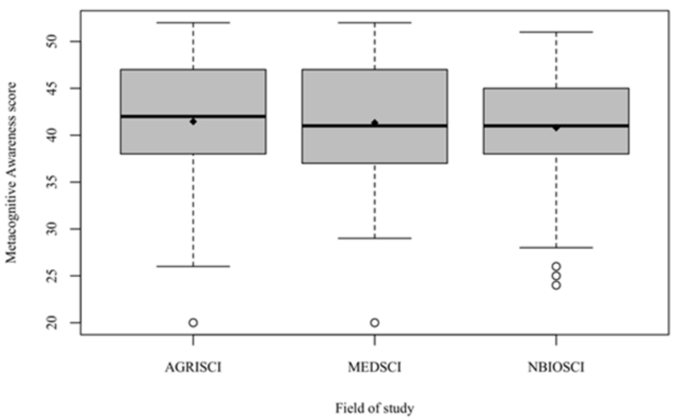

Figure 1b: Self-assessed metacognitive awareness scores for students in various biology-related programmes at University of Ibadan, Nigeria. Boxplots were drawn from the mean of raw scores for each item in questionnaire as assessed by respondents. Black points indicate overall mean, horizontal bars indicate median, circles indicate outliers. AGRISCI- Agricultural Sciences, MEDSCI- Medical Sciences, NBIOSCI- Natural Biological Sciences.

Table 2: Percentage scores in metacognitive awareness for different categories of students studying biology-related courses at University of Ibadan, Nigeria

Level	Mean Percentage score (%)
Year_1	82.4±0.1
Year_2	79.7±0.1
Year_3	77.4±0.1
Senior	79.3±0.1
Agricultural Sciences	81.6±0.1
Medical Sciences	80.9±0.1
Natural Biosciences	79.3±0.1
Overall	80.5±0.1

3.3 Metacognitive Knowledge

In each of the three sub-factors of metacognitive knowledge awareness, procedural, declarative or conditional knowledge, first year undergraduates affirmed their awareness on each item more often than second year undergraduates and other categories (Figure 2). Third year undergraduates had lower scores on each of the sub-factors.

3.4 Metacognitive Regulation

The self-assessed scores of senior students were lower than other groups in planning, information management and monitoring, but not in debugging strategies (Figure 3). In each of the sub-factors of metacognitive knowledge and regulation, the mean of the scores provided by respondents were high and close to maximum possible scores (Table 3)

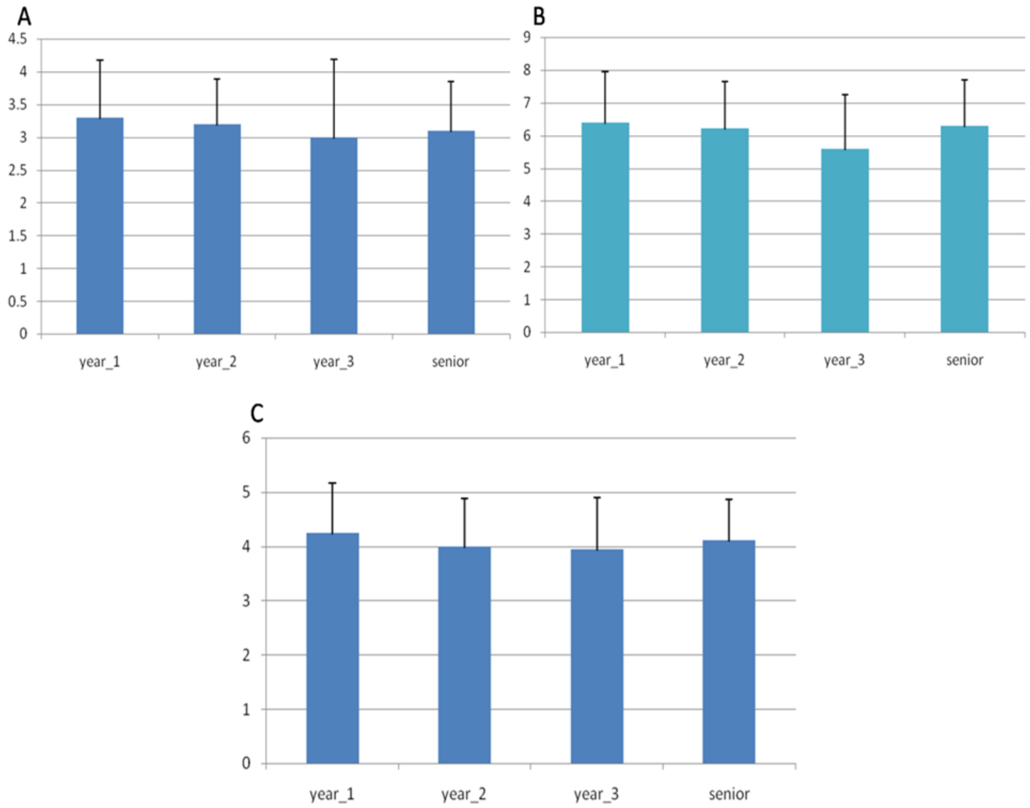

Figure 2: Mean scores of self-assessed awareness of metacognitive knowledge sub-factors among University of Ibadan students. Bars represent standard deviation. (A) Procedural Metacognitive Knowledge (B) Declarative metacognitive knowledge (C) Conditional metacognitive knowledge.

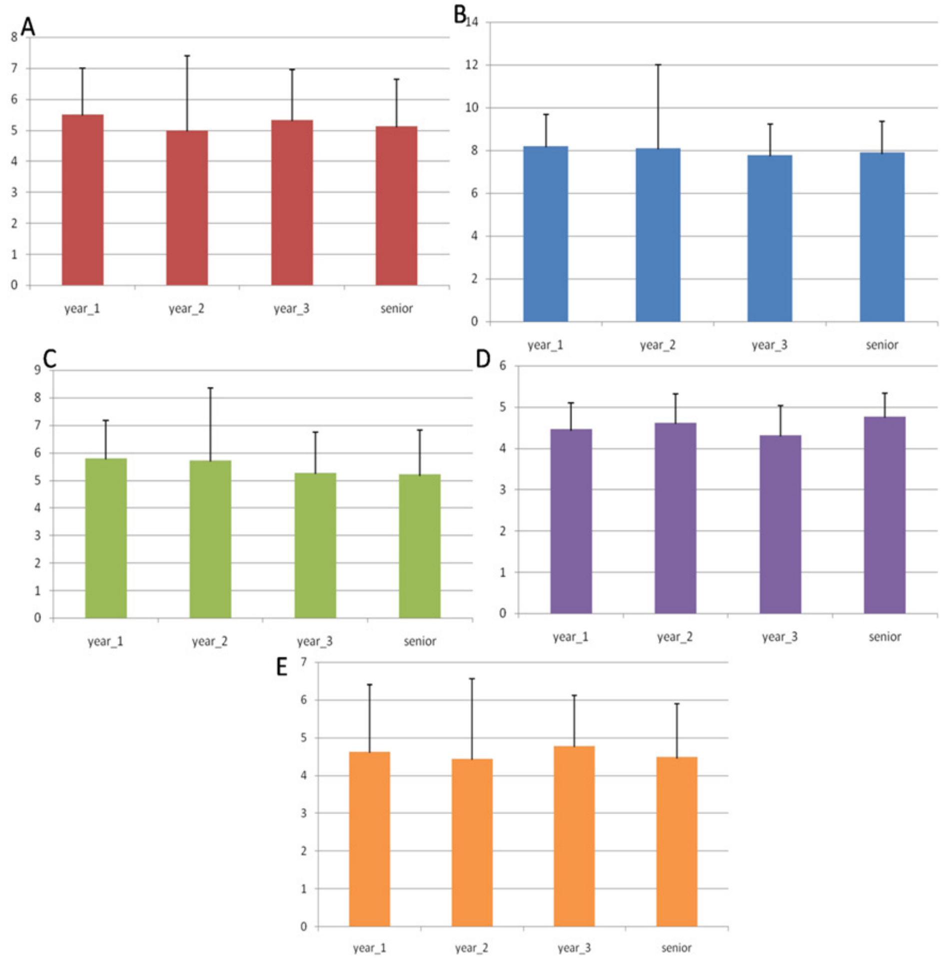

Figure 3: Mean scores of self-assessed awareness of metacognitive regulation among University of Ibadan students. Bars represent standard deviation. A. Planning B. Information Management C. Comprehension Monitoring D. Debugging E. Evaluation

Table 3. Levels of self-assessed metacognitive awareness among University of Ibadan students.

Awareness factor	Mean score	Standard Deviation	Maximum score
Metacognitive Knowledge			
Procedural Knowledge	3.19	0.84	4
Declarative Knowledge	6.23	1.51	8
Conditional Knowledge	4.12	0.88	5
Metacognitive Regulation			
Planning	5.27	1.57	7
Information Management	8.05	1.44	10
Monitoring	5.59	1.43	7
Debugging	4.55	0.76	5
Evaluation	4.56	1.59	6
Total score	41.56	1.2525	52

3.5 Associating perceived metacognitive knowledge with level of study or field of biology

For each category of procedural, declarative or conditional knowledge, the differences in percentage scores across the various levels of study were not significant (p=0.21-0.78). The percentage scores also did not statistically differ with department or field of biology (p=0.21-0.59). Considering metacognitive knowledge as a whole (all 3 sub-factors included), percentage scores barely associated with level of study and field of biology together (p=0.054, F=1.87), but did not associate with either of them separately.

3.6 Associating perceived metacognitive regulation with level of study or field of biology

Percentage scores in debugging strategies were related to level of study (p=0.012). For the other sub factors of metacognitive regulation, the differences in percentage scores across the various levels of study were not significant (p=0.42-0.96). The percentage scores did not statistically differ with department or field of biology (p=0.26-0.74). Considering metacognitive regulation/organization (all five sub factors included), percentage scores associated significantly with level of study (p=0.0127,) or level of study and field of biology together (p=0.005, F=2.69, Wilks' lambda = 0.80), but not with field of study as a single parameter.

4. Discussion and Conclusion

In this study, metacognitive awareness among students of the University of Ibadan, Nigeria was examined using the MAI tool. Data from the study provides a basis for improving academic success using metacognition strategies. Cronbach alpha test for reliability of the coded data was 0.76. The mean raw and percentage scores of the students on the MAI were generally high (Table 2 and Table 3). On average, a student's levels of metacognitive awareness reached 41.56 (79.9%) of a possible 52. This was higher (based on percentage) than mean MAI scores of 75 university students reported from the Middle East in Abdellah (2015), in which the scores were 188.1 (72.3%) of a possible 260 for students with science background (also the focus of the current study). The increase in scores of the students observed in the current study compared to that of the Middle East study, is most likely driven by higher scores in regulation of cognition rather than knowledge of cognition because percentage scores in knowledge were similar (79.9% to 82.3%) while those of regulation were not (80.0% to 66.8%). Abdellah (2015) also noted that students with a literary background scored higher: 208.6 (80.2) of 260.

High scores on the self-assessed metacognitive awareness inventory scale directly indicate that the students would score themselves excellent grades in their ability to control their own learning process. Data from this study suggests that students offering biology-based courses at the University of Ibadan believe strongly that they knew about their cognitive abilities and even believe more strongly that they could control these abilities.

While there was variation in the MAI scores, students in the second year in the University had the highest standard deviation values in all five sub-factors of metacognitive regulation and a standard deviation >2 in 4 out of the 5 five sub-factors of metacognitive regulation/organization. Similarly, the mean scores of Year 1 (first year) students were highest in 6 of the 8 sub-factors of metacognitive awareness – in all 3 sub-factors of metacognitive knowledge and in sub-factors of regulation except debugging and evaluation strategies. These observations may be influenced by confidence levels. Students in the second year of study have just had a relatively new experience as university students and the confidence in or perception of their own abilities may be shaped by their first-year academic success as well as recent introduction into university life.

Senior students in third or fourth year tended to report that they are stable while first year students are overwhelmingly confident in their abilities, having been admitted into the university. Oz (2016) also observed that many university students scored themselves high in metacognition awareness in a study of 104 students in Turkey. Specifically, for the current study, in metacognitive awareness, first year undergraduate students think highly of their cognition while second year students appear unsure of themselves in most metacognition factors compared to other students.

Some factors of self-assessed metacognitive awareness were influenced significantly by level of study and/or field of study. For instance, the differences observed in debugging among different levels of study was significant. Debugging is a key sub-factor of metacognitive regulation which involves ability to correct performance errors and wrong comprehension. The data (Figure 3D) indicates an increase in debugging abilities among the students, with the possible exception of those in their third year. Generally, it can be deduced that seniors believed, more than other undergraduates, that they know what to do when there is a learning problem to be tackled. Also, there was some form of association of the percentage scores of students and both their field and level of study jointly. This association was very strong statistically in metacognitive regulation compared to metacognitive knowledge. The year or level of study played a significant role in the percentage scores for metacognitive regulation.

The current study may have limitations. The sample population was small; it included 210 students in biology-based courses. It is possible that a larger sample size may improve the results and make the results more generalizable to the entire population. Also, the current study focuses on whether each respondent believed he or she was metacognitively aware or not. We did not make a comparison in the gradation in students' belief about their metacognitive awareness with regard to others'. Future work will compare students' metacognitive skills and awareness to their academic scores before and after some training in improving that metacognitive skill set.

To conclude, in the current study we provide data which suggests that the University of Ibadan biology students have a strong belief in their metacognitive awareness; and for many metacognition sub-factors, this belief reduces as the students progress through their course.

5. Acknowledgements

CIA acknowledges the World Health Organisation RCS/KM short term training grant B40394. RDI acknowledges awards EHR-1435186; EHR-1623371, EHR-1626602, CSE-1829717 from the U.S. National Science Foundation. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

References

Abdellah, R., 2015. Metacognitive awareness and its relation to academic achievement and teaching performance of pre-service female teachers in Ajman University in UAE. Procedia-Social and Behavioral Sciences, 174, pp.560-567.

Ajaja, O.P. and Agboro-Eravwoke, U.O., 2017. Collection and Analysis of Students' Metacognitive Orientations for Science Learning: A Survey of Science Classrooms in Delta State, Nigeria. Electronic Journal of Science Education, 21(8), pp.1-20.

Adedipe, T.H. and Ofodu, G.O., 2011. Assessing ESL students' awareness and application of metacognitive strategies in comprehending academic materials. Journal of Emerging Trends in Educational Research and Policy Studies, 2(5), pp.343-346.

Akin, A., Abaci, R. and Çetin, B., 2007. The validity and reliability of the Turkish version of the metacognitive awareness inventory. Educational Sciences: Theory & Practice, 7(2), pp. 671-678.

Alaiyemola, F.F., Jegede, O.J. and Okebukola, P.A., 1990. The effect of a metacognitive strategy of instruction on the anxiety level of students in science classes. International Journal of Science Education, 12(1), pp.95-99.

Avargil S., Lavi R., Dori Y.J. (2018) Students' Metacognition and Metacognitive Strategies in Science Education. In: Dori Y., Mevarech Z., Baker D. (eds) Cognition, Metacognition, and Culture in STEM Education. Innovations in Science Education and Technology, vol 24. Springer, Cham

Azevedo, R., 2009. Theoretical, conceptual, methodological, and instructional issues in research on metacognition and self-regulated learning: A discussion. Metacognition and Learning, 4(1), pp.87-95.

Clark, R. and Harrelson, G.L., 2002. Designing instruction that supports cognitive learning processes. Journal of athletic training, 37(4 suppl), pp.S-152.

de Boer, H., Donker, A.S., Kostons, D.D. and van der Werf, G.P., 2018. Long-term effects of metacognitive strategy instruction on student academic performance: A meta-analysis. Educational Research Review, 24, pp.98-115.

Ellis, A.K., Denton, D., Bond, J. 2014. An analysis of research on metacognitive teaching strategies. Procedia - Social and Behavioral Sciences 116, 4015 – 4024.

Eluemuno, A. and Azuka-Obieke, U., 2013. The effect of metacognitive skills on performance in English language among senior secondary school students in Anambra State, Nigeria. Journal of Emerging Trends in Educational Research and Policy Studies, 4(4), pp.678-685.

Gengle, H.I., Abel, M.A., Mohammed, B.K. 2017. Effective teaching and learning strategies in science and mathematics to improve students' academic performance in Nigeria. British Journal of Education, Society & Behavioural Science 19(1): 1-7, 2017

Ijiga, P.A., 2014. Effect of modes of video presentation of metacognitive strategies on secondary school students' achievement in reading comprehension in North Central Nigeria. Journal of Education and Vocational Research, 5(4), pp.216-227.;

Jain, D., Tiwari, G.K., Awasthi, I.D. 2017. Impact of metacognitive awareness on academic adjustment and academic outcome of the students. The International Journal of Indian Psychology. 5(1): doi:10.25215/050.034

Kistner, S., Rakoczy, K., Otto, B., Dignath-van Ewijk, C., Buttner, G., Klieme, E. 2010. Promotion of self-regulated learning in classrooms: Investigating frequency, quality, and consequences for student performance. Metacognition and Learning, 5(2), 157-171.

Kohen, Z. and Kramarski, B., 2018. Promoting mathematics teachers' pedagogical metacognition: A theoretical-practical model and case study. In Cognition, Metacognition, and Culture in STEM Education (pp. 279-305). Springer, Cham.

Maduabuchi, C.H., Angela, I.O.I. (2016). Teaching metacognitive skills for the promotion of self-regulated learning among secondary school students in Nigeria. British Journal of Education, 4(10), 74-84.

Nbina, J. and Viko, B., 2010. Effect of instruction in metacognitive self-assessment strategy on chemistry self-efficacy and achievement of senior secondary school students in rivers state, Nigeria. Academic Leadership: The Online Journal, 8(4), p.19.

Okoza, J. and Aluede, O., 2014. Fostering metacognitive awareness among teachers: Implications for the Nigerian school system. Africa Education Review, 11(4), pp.614-637.

Okoza, J., Aluede, O. and Owens-Sogolo, O., 2013. Assessing students' metacognitive awareness of learning strategies among secondary school students in Edo State, Nigeria. Research in Education, 90(1), pp.82-97.

Onu, V.C., Eskay, M., Igbo, J.N., Obiyo, N. and Agbo, O., 2012. Effect of training in math metacognitive strategy on fractional achievement of Nigerian schoolchildren. US-China Education Review B 3 316-325.

Öz, H. 2016. Metacognitive awareness and academic motivation: a cross-sectional study in teacher education context of Turkey. Procedia - Social and Behavioral Sciences 232: 109 – 121.

Schraw, G., 1998. Promoting general metacognitive awareness. Instructional science, 26(1-2), pp.113-125.

Schraw, G., Dennison, R.S. 1994. Assessing metacognitive awareness. Contemporary Educational Psychology, 19, 460-475.

Young, A. and Fry, J.D., 2008. Metacognitive awareness and academic achievement in college students. Journal of the Scholarship of Teaching and Learning, 8(2), pp.1-10.

Young, A.E. and Worrell, F.C., 2018. Comparing metacognition assessments of mathematics in academically talented students. Gifted Child Quarterly, 62(3), pp.259-275.