SciencePlus
Vol. 2 Nomor 2 Oktober 2026
ISSN. 3090-3564
https://journal.barkahpublishing.com/index.php/sp

RELATIONSHIP BETWEEN STUDENTS' METACOGNITIVE SKILL AND STUDENTS' ACADEMIC ACHIEVEMENT IN BIOLOGY IN PUBLIC SECONDARY SCHOOLS IN ANAMBRA STATE NIGERIA

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Abstract

A correlational study was conducted to examine the correlation between self-regulatory skills and academic achievement in Biology of Senior Secondary 2 students of Anambra State. A multi-stage sampling technique was used to select 18 public secondary schools with 637 pupils from the Awka and Otuocha education zones. Two validated and reliable structured scales and official third-term grade books were used to collect data which were analyzed using Pearson Product Moment Correlation and multiple regression analyses at the 0.05 level of significance to test the hypotheses. The total population of 637 secondary school students in Anambra State were used for the analysis and the relationship between metacognitive skill and academic achievement in Biology among the secondary school students was determined. The result showed that there was a low positive correlation ($r=.026$, $R^2=.001$). This relationship was not statistically significant as shown by regression analysis: $F(1,635)=0.792$, $p=.374$. The data did not support the rejection of the null hypothesis ($p>.05$), thus supporting the hypothesis, which states that there is no significant linear relationship between metacognitive skills and students' achievement score in Biology in the public secondary schools of Kano state. The study findings recommended that the educational stakeholders move beyond metacognitive awareness and integrate in subject-specific pedagogical interventions and supporting resources that would further improve students' understanding of biology concepts in the secondary school..

Keywords: *Metacognitive Skills, Academic Achievement, Biology, Correlational Study, Senior Secondary Students, Anambra State.*

INTRODUCTION

The cognitive processes that influence students' achievement in science subjects have continued to be a central issue in science education research. Metacognition can be thought of as thinking about thinking and involves the awareness, monitoring, and self-regulation of cognitive processes in learning activities. When students meet complex biology concepts in secondary school, they need to have good metacognitive skills to process abstract concepts, arrange theories and perform a problem solving process. The learning process between students' metacognitive skills and their learning achievement in Biology is a complex process in which personal regulation, learning orienting and technology application as well as overall learning system factors play a role in the secondary education.

The metacognitive skills are the skills for autonomous learning, which equip students to set goals, choose appropriate learning strategies and check their understanding level in learning activities. Our findings suggest that self-efficacy is a companion to metacognition in the context of scientific learning environments to develop academic achievement. The results of the research show that the self-regulatory behavior of students in science learning is improved by increasing their self-efficacy and strategic metacognition, as evidenced by the success of science learning.The results of the research showed that students' self-efficacy and strategic metacognition were able

to improve the overall science learning outcomes through self-regulated behavior in students' learning. If students are confident in their ability to learn biology, then they will be more likely to use reflective strategies, assess their learning, and correct misconceptions. In addition, structural equation modeling showed that self-efficacy had a direct and indirect impact on the learning outcomes of Biology mediated by the self-regulated learning frameworks, as shown in the model as follows. The constructs of metacognitive skills also play a crucial role in predicting academic self-efficacy in secondary education, suggesting a bidirectional link between metacognition and academic self-efficacy, as well – self-efficacy influences metacognition, and metacognition influences self-efficacy (Adie et al., 2026). In addition to the science subjects, there are also positive correlations between metacognitive awareness and the results of students' performance in quantitative and analytical subjects related to science (Yarcia & Nangpuhan, 2026).

Although metacognition is theoretically regarded as one of the salient factors for learning, there are sometimes empirical studies that find complex realities in classroom settings as the sole result of the raw correlational values. A study on self-regulatory skills as correlates of Biology achievement among senior secondary school students in Anambra State reveals that self-regulatory skills are individual sub-domains which do not necessarily have high isolated predictive power (Rita & Henrieta, 2025). The finding indicates that the possession of metacognitive awareness is not sufficient for achieving high test scores as long as there are no other factors, such as the content knowledge in the field, the instructional scaffolding, and the learning resources.

Deliberate instruction implementing metacognitive prompts in active learning contexts has been shown to consistently improve academic achievement. The metacognitive scaffolding is found to significantly increase students' motivation, conceptual understanding, and overall academic performance in Biology, as shown in the results (Eticha et al., 2025). The use of guided inquiry strategies in conjunction with instructional scaffolding offers clear pathways for secondary students to cultivate critical thinking during the course of their learning in Biology to support the attainment of educational targets (Deanoval et al., 2026). In addition, metacognitive scaffolding in OIBL improves students' scientific inquiry skills, metacognition, and scientific performance (Gao et al., 2026). For collaborative settings, the structured metacognitive scaffolds in groups lead high school students to work together to communicate and solve complex problems in biology together (Weng & Ren, 2026).

The integration of modern technology in science education spaces provides great opportunities to activate metacognitive strategies and promote learning. Animated education content, for example, is a dynamic visual educational aid that makes biological phenomena easier to understand. The use of computer animation in secondary school classes improves students' understanding of complex processes in Biology, which they cannot easily understand by themselves (Nnalue et al., 2024). Interactive digital resources further engage students in the study of biology concepts and stimulate their eagerness to learn biology (Nnalue et al., 2023). In addition to animation, new educational technology like adaptive learning platforms and artificial intelligence can help to provide responsive learning environments that reflect metacognitive feedback loops. AI-driven educational leadership promotes personalized learning progress specific to a student's learning pace and cognitive needs (Ofozoba et al., 2024). AI-based service-learning and sustainability topics enrich the understanding of higher-order concepts like green nanomaterials and nanotechnology while encouraging active reflection in real-world applications (Ofozoba et al., 2025; Anakpua et al., 2025). The technology of gamification also helps to enhance basic educational results and students' motivation to study subjects related to technology (Enem et al., 2025).

There are significant teacher readiness, infrastructure and institutional contexts that are required for tech assisted metacognitive strategies to be successful. Analysis of chemistry and science teaching has shown that the views of the teachers and students on the use of ICT influence the effectiveness of their use in secondary school classrooms (Nnoli & Muogbo, 2025). In the regional school districts, teachers' awareness and implementation of innovative pedagogical methods have a strong impact on the learning environment (Christian-Ike et al., 2024). Additionally, basic science teachers' attitudes toward virtual learning spaces influence how smoothly blended learning models are executed (Christian-Ike et al., 2025a). Structural challenges, infrastructure deficits, and gender dynamics further impact the feasibility of blended learning environments across educational institutions (Okelue et al., 2025). When infrastructure is supported, experiential learning approaches provide practical immersion that significantly boosts academic achievement in technical and science subjects (Muogbo et al., 2025).

Environmental, demographic, and familial factors also interface with cognitive skill development to influence student performance in secondary schools. Parental attitudes toward foundational education significantly affect students' academic achievement and inner motivation in basic science subjects (Christian-Ike et al., 2025b). Gender variables and school locations interact with students' development of practical science process skills, which remain critical predictors of overall science achievement (Obikezie et al., 2025). Developing strong science process skills during secondary education provides the necessary foundation for tertiary education, where process mastery continues to predict academic performance in higher-level science courses (Chukwunazo et al., 2025).

Combining these empirical viewpoints indicates that student metacognition is a key internal system in the learning process, but that it must be supported by external systems to become a high achievement in their study of Biology. The combination of explicit teaching, scaffolding, the use of modern technological means, active parental involvement, and a supportive school environment enables students to apply metacognitive monitoring to engage effectively with concepts in biology. This is an important educational challenge because of the consistent poor performance in Biology and low interest of the students in secondary Schools in Anambra State. While the fundamental nature of Biology is essential in the fields of STEM, many learners have difficulties in complex concepts. The aim of this study was to investigate the effect of students' limited use of self-regulatory mechanisms, namely metacognitive skills such as self-monitoring, planning and evaluation, on these academic weaknesses. The research will examine the correlations between metacognitive strategies and actual achievement results to provide empirical evidence for educators, curriculum developers, and policy makers to design specific pedagogical interventions to optimize students' learning outcomes in science.

METHOD

The relationship between metacognition and academic performance in Biology for the senior secondary school students in Anambra state was examined. The study specifically examined whether students' ability to monitor and regulate their thinking processes is associated with their performance in Biology in secondary school, given the continued concerns about low average student performance in science in secondary school. The method used in this study was systematic in order to explore the self regulatory skills as correlates of academic achievement and interest in Biology of senior secondary school students systematically. The correlational research design was used, as it is suitable for the type of data to be collected from a representative sample of students, with the aim of establishing relationships between the independent and dependent variables.

This study was conducted in Anambra State, South-east geopolitical zone of Nigeria. Anambra State has 21 Local Government Areas with six Education Zones (Aguata, Awka, Nnewi, Ogidi, Onitsha, and Otuocha) and is blessed with abundant natural resources, agricultural production, and a major commercial center in Onitsha and an industrial center in Nnewi. The field investigation focus was on Secondary schools in the Awka and Otuocha education zones. Anambra State was selected based on observed low average academic performance of students and their interest in Biology which could be attributed to the absence of effective SRL strategies among students.

Records of the State Post Primary Schools Service Commission, Awka revealed that there were 14,767 Senior Secondary 2 (SS 2) students in the study population that were spread across 268 public secondary schools of the state at the time of data collection in July, 2024. A sample of 637 SS 2 Biology students from this target population was sampled, corresponding to about 5% of the population, a sampling proportion comparable to the one used for large population of several thousand students, in accordance with the accepted sampling methodology for such population.

A multi-stage sampling procedure was used for the selection of the students for participation. The first two education zones were picked, these are Awka and Otuocha. Three LGAs were then randomly picked from each of the 2 selected zones, making a total of 6 LGAs – Njikoka, Awka South, Anaocha, Anambra East, Anambra West and Ayamelum. Lastly, 18 secondary schools were selected from a list of public secondary schools in each local government area (LGA), and this selection was made randomly to get three secondary schools from each of the 18 LGAs. The respondents consisted of all eligible students in the selected schools in SS 2 in Biology, giving a final sample size of 637 respondents.

The data collection instruments used was a structured instrument that was developed by the researcher after the literature study and consultation with the subject matter experts. The instrument contained items in Biology concepts in 4-point frequency scale (Always to Never). The academic achievement data came from official grade book of third term of 2023/2024 academic session, which has been checked and confirmed by the head of school and subject teachers.

The instruments were face and construct validated to guarantee the validity. The items were rated for clarity, coverage, relevance and accuracy of content by three experts, two of whom were specialists in Biology Education, and one was a specialist in Measurement and Evaluation, both from Nnamdi Azikiwe University and Chukwuemeka Odumegwu Ojukwu University. Principal component analysis was used with Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy to satisfy the construct validity, the coefficient value was 0.869. The reliability was obtained through trial testing by administering the instrument to 20 SS 2 students of Biology class in the neighbouring states of Enugu. Internal consistency reliability estimates for the instrument was determined using Cronbach's alpha.

The researchers and five trained research assistants gave the questionnaires directly to students in their classrooms during administration, with prior official permission from school principals through introductory letters. Responses were collected on site to maximize response rates. Data were analyzed using SPSS version 23. Analysis of data was done in SPSS version 23. The research questions 1 to 8 were answered using Pearson Product Moment Correlation, and research questions 9 and 10 were answered using multiple regression analysis. The hypotheses 1–8 were tested by t-test of correlation at the 0.05 significance level while the hypotheses 9 and 10 were tested by multiple regression analysis. The null hypotheses were denied if P value was less than 0.05.

RESULT AND DISCUSSION

Research Question: What is the relationship between students' metacognitive skill and students' academic achievement in Biology in public secondary schools in Anambra State?

Table 1: Pearson correlation coefficient (r) on students' metacognitive skill and students' academic achievement in Biology.

Model	N	R	R^2	Adjusted R^2	Std. Error	Decision
METACOGNITIVE SKILL	637	.026	.001	-.001	10.11975	Low Positive relationship
ACHIEVEMENT						

Table 1 reveals correlation coefficients (r) of .026 on students' metacognitive skill on students' interest. This implies that the relationship between students' metacognitive skill and students' interests in biology is low and positive.

Hypothesis: There is no significant relationship between students' metacognitive skill and students' achievement in Biology in public secondary schools in Anambra State.

Table 2: Test of Significance of Correlation between students' metacognitive skill and students' achievement in Biology

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	745.944	1	745.944	.792	.374[b]
	Residual	598388.198	635	942.344		
	Total	599134.141	636			

a. Dependent Variable: ACHIVEMENT

b. Predictors: (Constant), METACOGNITIVESKILL

Table 2 shows that students' motivation skill has no significant relationship with the students' academic achievement scores in biology F (1,635) = 0.792, P (0.374) > 0.05. The null hypothesis is rejected meaning that metacognitive skill has no significant relationship with students' achievement in Biology in public secondary schools in Anambra State.

Discussion

The research question was aimed at determining the relationship between students metacognitive skills and their academic performance in Biology in public secondary schools in Anambra State. Table 1 showed that the Pearson correlation coefficient (r) was .026 and the coefficient of determination (R^2) was .001. This means that there is a very weak positive correlation between metacognitive skills and academic outcome in Biology. Xie (2026) found a strong interaction between metacognitive strategies and self-efficacy that improves learning outcomes in blended science learning environments, while this weak baseline correlation was not reported. Likewise, the study conducted by Yarcia and Nangpuhan (2026) found that there was a direct meaningful relationship between metacognition and academic achievement for secondary school students. This finding, however, corroborated the fine-grained view put forward by Palullu et al. (2026) who emphasized that while metacognition may affect learning outcomes directly, it is necessary to be fully mediated by the active SRL behaviors.

As for the null hypothesis, for this analysis, the result of the ANOVA regression was F(1,635)=0.792, p=.374. Since p>0.05, the relationship is considered statistically non-significant and thus the null hypothesis is not rejected. Structured metacognitive intervention, on the other hand, was found to increase learning motivation and learning

achievement significantly in Biology classrooms (Eticha et al., 2025). In a related study, Gao et al. (2026) showed that metacognitive scaffolding that is embedded in inquiry-based science learning has significant positive effects on overall science achievement and inquiry skills. Moreover, Deanoval et al. 2026 developed the significant relationship between guided inquiry and metacognitive scaffolding with critical thinking and academic performance in Biology.

The lack of a significant correlation found in this study indicates that self-reported metacognitive awareness, without external instructional assistance, is not necessarily correlated with improved performance in school. Weng and Ren (2026), on the other hand, argued that metacognition contributes to significant academic achievement more when integrated into active, collaborative scaffolds. Likewise, Adie et al. (2026) found that metacognitive skills worked well as predictors when they were used as a component of academic self-efficacy as opposed to being compared against direct test scores.

The result obtained indicates that metacognitive skills and achievement in Biology is not significantly correlated, this has important educational implications in secondary education in Anambra State. First of all, it shows that when students' passive metacognition is not guided by a structured presentation of the content, it fails to enable them to master the material. Intrinsic self-regulation alone is not enough for teachers, they should incorporate specific motivation and self-esteem development in the lesson to stimulate success in biology (Ezeanyagu et al., 2023). Besides, some science concepts are more complex to learn, as is the case with secondary physics learners who struggle with concepts in mathematics without any instruction (Ugonwa, 2015).

In order to fill this gap, it is necessary to equip teachers with new teaching methods that can help students develop metacognitive abilities. The use of elaborately produced rich multimedia instructions can stimulate interest in learning and make abstract concepts more accessible (Johnson et al., 2026). Implementing technology-supported pedagogy, however, demands a need for digital competence enhancement across schools, which means that tackling computer literacy among students (Enemuo et al., 2025) and enhancing science teachers' computer literacy and integration of technology into teaching (Nneka & Okafor, 2013) are still very important. In the end, effective learning strategies enable youth development which helps to reap the positive contribution of the youth to the development of the country (Mezieobi et al., 2022).

CONCLUSION

The findings of this study based on the empirical data obtained indicated that there was a very low positive correlation between metacognition and academic performance of the senior secondary school students in Anambra state in Biology. In addition, inferential statistical analysis showed that this relationship is not statistically significant. Thus, metacognition in isolation (without intentional scaffolding or external scaffolding) is not necessarily correlated with better academic test scores in Biology.

The results reaffirm that the use of students' self-regulated or self-learner metacognition is not enough to fix the problem of average student achievement and low level of interest in the study of Biology in public secondary schools. Metacognitive skills are still an integral part of the learning process, but they cannot ensure substantial academic results without effective pedagogical practices, explicit teacher scaffolding, participatory learning technologies, and real world learning contexts. Educational stakeholders would thus need to go beyond the assumption that solely self-regulated learning equates with academic achievement, and instead devise effective science teaching that has built-in scaffolding and metacognitive cues that are explicitly linked to conceptual learning.

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