Metacognition as Correlate of Academic Achievement and Motivation of pre-service teachers in Electrical-Electronics Devices in Colleges of Education in Kano State, Nigeria

by
[1]Hassan Yunusa Jamilu, Ph.D, *[2]Suleiman Abubakar
[1]DEPARTMENT OFINDUSTRIAL AND TECHNOLOGY EDUCATION, BAYERO UNIVERSITY KANO, NIGERIA

[2]DEPARTMENT OFINDUSTRIAL AND TECHNOLOGY EDUCATION, BAYERO UNIVERSITY KANO, NIGERIA
***Correspondence:** modibbo20@gmail.com

Abstract
The study investigated the metacognition as correlate of academic achievement and motivation of pre-service teachers in Electrical-Electronics Devices in Colleges of Education in Kano State, Nigeria. The study was guided by two research questions while two hypotheses were tested at 0.05 level of significance.. A correlational research design was adopted for the study. The population for the study consisted of all ninety-three (93) NCE II students offering Electrical-Electronics Devices in the three NCE technical awarding institutions in Kano State. Three instruments were used for data collection: the Electrical-Electronics Devices Metacognition Inventory (EEDMI), Electrical-Electronics Devices Motivation Questionnaire (EEDMQ), and the Electrical-Electronics Devices Achievement Test (EEDAT). The instruments were validated by three experts in the department of industrial and technology education. The reliability of the questionnaire was established using Cronbach alpha reliability method, which yielded reliability coefficients of 0.898 for EEDMI and 0.779 for EEDMQ, while Kuder-Richardson Formula 20 (KR-20) was used for the EEDAT, which yielded a reliability coefficient of 0.839. Data collected were analyzed using Pearson Product Moment Correlation method for answering research questions while the hypotheses were tested using regression analysis at the 0.05 level of significance. The findings revealed a strong positive and statistically significant relationship between metacognition and academic achievement (r = .601), as well as between metacognition and motivation (r = .850). It was recommended, among others, that educators in Colleges of Education should integrate theteaching of metacognitive strategies, such as modeling thinking aloud during troubleshooting to show students how to regulate cognitive processes.
Keywords: Metacognition, Academic Achievement, Motivation, Pre-service Teachers, Electrical-Electronic Devices.

Introduction

The Nigeria Certificate in Education (NCE) Technical programme is a three-year post-secondary education, designed to provide technical teacher trainees with the intellectual and professional foundation required to teach technology-related subjects at the post-primary level. The programme is offered at colleges of education (technical), conventional colleges of education, and polytechnics, culminating in the award of the NCE (Technical) certificate, recognized as the minimum teaching qualification in Nigeria (National Commission for Colleges of Education [NCCE], 2020). Students are trained in various specializations, including automobile technology, building technology, electrical/electronic technology, metalwork technology, and woodwork technology (Salihu & Nordin, 2019).

Electrical/electronic technology education encompasses the study and application of electricity, electronics, and electromagnetism. It includes the design,

installation, maintenance, and operation of electrical and electronic systems, alongside the principles and methodologies of teaching (Lawal et al., 2023). Trainees in this specialization undertake courses such as Entrepreneurship in Vocational and Technical Education, Electrical Machines and Power, Telecommunications, Electrical Circuits and Measuring Instruments, Electrical-Electronic Devices, Digital Electronics, and Methods of Teaching Technical Subjects. These courses are intended to equip students with the skills necessary for their roles in national development (Zechariah & Tumba, 2024).Among these courses, Electrical-Electronic Devices was deliberately selected for this study due to the persistently high failure rate recorded among students over successive academic sessions in colleges of education in Kano state, indicating underlying challenges in comprehension, instructional delivery, or learner motivation. The course focuses on the principles, characteristics, operation, and applications of fundamental electronic components such as diodes, transistors, integrated circuits, amplifiers, and power devices, which serve as the foundation of modern electronic systems(Petrov et al., 2021).Mastery of Electrical-Electronic Devices is essential for students, as it enhances their analytical thinking, problem-solving abilities, practical troubleshooting skills, and readiness for careers in electronics, telecommunications, automation, and related fields.

Beyond its academic value, competence in Electrical-Electronic Devices has broader societal relevance, supporting innovation, industrial development, technological self-reliance, and the maintenance of critical electronic infrastructure (Nemchinski, 2020). By strengthening students' understanding of this course, educational institutions can contribute to producing skilled technical educators and practitioners capable of driving sustainable technological advancement and addressing workforce demands in an increasingly digital and electronics-driven society.

The disparity in technological advancement between developed and developing countries can be largely attributed to their respective levels of progress in technology education, including electrical/electronic technology education (Egboh, 2020). Smith (2023) further noted that advancements in electrical and electronic devices, such as miniaturization, enhanced processing power, and advanced communication technologies, are being applied across sectors including healthcare, automotive, consumer electronics, industrial automation, and renewable energy. These innovations are prominently seen in global hubs like Silicon Valley, South Korea, China, and other leading research institutions. This highlights the urgency for Nigeria to bridge the technological gap in this area by creating conducive environments that motivate students to attain significant academic feat.

Despite the recognized significance of electrical/electronic technology education in preparing competent electronics pre-service teachers to drive technological development in Nigeria, several challenges persist. According to Igberadja (2020), these challenges hinder academic achievement and diminish motivation, thus affecting readiness for the teaching profession. Consequently, the country risks forfeiting the potential benefits of this educational programme. Prior studies have examined various factors influencing students' academic achievement and motivation in electrical/electronic courses. Identified factors include interest, perception, metacognition and critical thinking (Mart, 2022). To effectively address these challenges, it is necessary to explore the underlying factors impeding academic achievement and motivation, particularly in the Electrical and Electronic Devices course offered at the NCE

2 level. A crucial factor in this regard is metacognition.

Metacognition refers to students' ability to reflect on and regulate their thinking processes. It was defined as an individual's awareness and understanding of their cognitive functions (Celik, 2022). It involves evaluating, monitoring, and controlling learning processes (Mart, 2022). Wagaba (2018) identified two key components of metacognition: knowledge of cognition and regulation of cognition. The former involves understanding the strategies used in learning and one's cognitive processes, while the latter pertains to selecting, applying, monitoring, and adjusting these strategies as needed.

From a neuroscientific standpoint, metacognition is associated with the prefrontal cortex (PFC), which governs executive functions such as error detection, planning, and adaptive learning (Li et al., 2023). In the context of the Electronics Devices course, for instance, an electronic pre-service teacher might realize difficulty in understanding circuit diagrams (metacognitive knowledge), devise a plan to practice diagram interpretation, monitor their progress through problem-solving exercises, and seek clarification when challenges persist (metacognitive regulation). This active engagement enhances understanding and consequently, higher academic achievement (Abdelrahman, 2020).

Academic achievement remains a critical objective of educational programmes. It refers to the level of knowledge and skills acquired, typically assessed through standardized or teacher-made tests (Ozcan, 2021). As a key indicator of educational outcomes, academic achievement is instrumental to national advancement in science, technology, and the economy. Consequently, stakeholders, including parents, teachers, and policymakers, are deeply invested in strategies to enhance it (Josephine & Osadebamwen, 2023). Neuroscientific research into metacognition within electronics engineering field reveals fascinating interactions between cortical networks and learning outcomes that have profound implications for academic achievement.

Studies in cognitive neuroscience (Fleming, 2020; Morales, 2018) have identified the prefrontal cortex as central to metacognitive monitoring. The dorsolateral prefrontal cortex (DLPFC) contributes to strategic planning and working memory, while the anterior cingulate cortex (ACC) facilitates error detection. These regions are particularly active during problem-solving tasks, such as those encountered in Electrical and Electronic Devices. Morales (2018) reported that metacognitive awareness, such as self-questioning during circuit design, activate the anterior prefrontal cortex. This action enhances hippocampal-prefrontal connectivity and promotes long-term retention of technical knowledge (Bettio et al., 2022). A study by Li et al, (2023) confirmed that students with heightened metacognitive awareness achieved higher scores in electronics devices assessments. These revelations suggest a potential correlation between metacognition and academic achievement among electronics pre-service NCE technical teachers. Metacognitive awareness fosters goal-setting, progress monitoring, and a sense of accomplishment, which could in turn enhance motivation (Efklides, 2021).

Motivation can be seen as the drive to initiate, exert effort in, and persist with a task. It is a pivotal component of human behavior and a key determinant of academic success (Torres &López, 2020). Self-determination theory (SDT) categorizes motivation into two types: intrinsic motivation (IM) and extrinsic motivation (EM) (Zacolleti, 2020). IM involves engaging in tasks for inherent satisfaction, while EM arises from external rewards (Guay et al., 2019). Metacognition plays a vital role in sustaining motivation (Fleming, 2020). Students who effectively

regulate their learning often feel more competent and in control, thereby cultivating intrinsic motivation (Zohar &Barzilai, 2019). For example, a pre-service teacher in electronics devices course who overcomes a difficult concept through strategic effort, experiences satisfaction that fuels further learning. In contrast, those lacking metacognitive awareness may feel overwhelmed and lose motivation (Dinsmore, 2018).

The link between metacognition and motivation is multifaceted and involves the interplay of cognitive control and reward processing, which combine to give an individual a sense of accomplishment. This sense of progress and mastery activates the mesolimbic dopamine pathway, associated with pleasure and reinforcement (Murayama, 2021). The release of dopamine not only reinforces the learning behaviors that lead to success but also enhances intrinsic motivation to engage further with the learning material (Chen, 2021). For electronics pre-service teachers, successfully learning the operation of a complex circuit or understanding a challenging concept through effective metacognition can trigger this reward response, fostering a greater motivation and drive to learn more about electronics devices (Li et al., 2023).

In view of the foregoing, the role of metacognition in enhancing academic achievement and motivation is profound. However, the specific influence of this constructs on academic achievement and motivation among electronic pre-service NCE technical teachers in Nigeria, particularly in Kano State, remains under-researched. This gap justifies the present study, which aims to examine the correlation between metacognition, academic achievement, and motivation in the Electrical-Electronic Devices course among pre-service teachers of colleges of education in Kano state, Nigeria.

Statement of the Problem

The electrical/electronic technology education as NCE (Technical) program in Nigeria is designed to produce highly qualified technical teachers in the area of electrical/electronic technology, capable of imparting essential knowledge and skills in Basic Technology to students in upper primary and junior secondary schools. Despite this noble objective, there has been a consistent failure rate in the electrical-electronics devices course among students in NCE (Technical) awarding institutions in Kano over the past six academic sessions, beginning 2019/2020 to 2024/2025. This means that the performances of pre-service electronics NCE technical teachersinelectrical-electronics devices in Kano state have been unsatisfactory in recent years. This persistent failure rate is a significant cause for concern and highlights the urgent need to address the underlying issues affecting these students' academic performance and motivation.

The continuous failure in the electrical-electronics devices course could result in a significant decline in the quality of electrical/electronic technology program in Kano state, undermining the program's objectives. Graduates may find themselves ill-prepared for teaching roles, lacking the necessary knowledge and confidence to effectively educate their students.Therefore, it is imperative to investigate the correlates of academic achievement and motivation, specifically focusing on metacognition among pre-service teachers in Kano-Nigeria.

Purpose of the Study

The purpose of the study was to investigate the correlation between Metacognition, Academic Achievement and Motivation of Pre-Service Teachers in Electrical-Electronics Devices in Colleges of Education in Kano State, Nigeria. Specifically, the study intended to:

1. find out the relationship between metacognition and academic achievement of pre-service teachers in electrical and electronics devices in colleges of education
2. determine the relationship between metacognition and motivation of pre-service teachers in electrical and electronics devices in colleges of education

Research Questions

The following research questions guided the study:

1. What is the relationship between metacognition and academic achievement of pre-service teachers in electrical and electronics devices in colleges of education?
2. What is the relationship between metacognition and motivation of pre-service teachersin electrical and electronics devices in colleges of education?

Hypotheses

The following hypotheses were tested at 0.05 level of significance:

$H0_1$ There is no significant relationship between metacognition and academic achievement of pre-service teachers in electrical and electronics devices in colleges of education.

$H0_2$ There is no significant relationship between metacognition and motivation of pre-service teachers in electrical and electronics devices in colleges of education.

Methodology

The study adopted a correlational research design. The study was conducted in Kano State of Nigeria. The population for the study consisted of all ninety-three (93) NCE II students offering Electrical-Electronics Devices in the three NCE technical awarding institutions in Kano State. Due to the manageable size of the population, a census sampling technique was employed, involving the entire population. Three instruments were used for data collection: the Electrical-Electronics Devices Metacognition Inventory (EEDMI), Electrical-Electronics Devices Motivation Questionnaire (EEDMQ), and the Electrical-Electronics Devices Achievement Test (EEDAT). EEDMI and EEDMQ have 27 and 18 items respectively with response options structured on a four point scale of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD), while EEDAT has 30 multiple choice items. The instruments were subjected to face and content validation by three experts and all necessary corrections were made based on their comments and recommendations.

The reliability of the questionnaire was established using Cronbach reliability Alphamethod which yielded reliability coefficients of 0.898 for EEDMI and 0.779 for EEDMQ,while Kuder-Richardson Formula 20 (KR-20) was used for the achievement test, which yielded a reliability coefficient of 0.839. Data collected were analyzed using Pearson Product Moment Correlation for answering research questions, while Simple regression Analysis was used to test the null hypotheses at the 0.05 level of significance respectively.

Results

The results of the study are presented in tables with respect to each research questions and hypotheses as follows.

Research Question 1

What is the relationship between metacognition and academic achievement of pre-service teachers in electrical and electronics devices in colleges of education?

Data for answering research question 1 are presented in Table 1

Table 1
Pearson Product Moment Correlation (PPMC) Result between Pre-service Teacher's Metacognition and Academic Achievement in Electrical and Electronics devices.

Variables	N	$\bar{x}$	SD	R	Remark
MET	93	102.81	5.14	.601	Strong positive relationship
AA	93	26.10	3.43		

Key: N = Number of the Respondents, $\bar{x}$ = Mean, SD = Standard Deviation, r = Correlation coefficient, MET = Metacognition, AA = Academic Achievement.

Table 1 presents the Pearson Product Moment Correlation (PPMC) results, indicating a mean Metacognition (MET) score of 102.81 with a standard deviation (SD) of 5.14, as well as a mean Academic Achievement (AA) score of 26.10 and an SD of 3.43. The correlation coefficient (r) of 0.601 was obtained. These results indicate that there is a strong positive relationship between pre-service teacher's MET and AA in electrical and electronics devices. This means that as pre-service teacher's MET increases, their AA also increases. Furthermore, SD result obtained implies that the responses of pre-service teachers on both MET and AA are close to the means.

Research Question 2

What is the relationship between metacognition and motivation of pre-service teachers in electrical and electronics devices in colleges of education?

Data for answering research question 2 are presented in Table 2

Table 2
Pearson Product Moment Correlation (PPMC) Results between Pre-serviceTeacher's Metacognition and Motivation in Electrical and Electronics devices

Variables	N	$\bar{x}$	SD	R	Remark
MET	93	102.81	5.14	.850	Strong positive relationship
MOT	93	68.67	3.38		

Key: N = Number of the Respondents, $\bar{x}$ = Mean, SD = Standard Deviation, r = Correlation coefficient, MET = Metacognition, MOT = Motivation.

The data presented in Table 2 reveals a Metacognition (MET) mean score of 102.81 and an SD of 5.14, while the Motivation (MOT) mean score is 68.67 with an SD of 3.38. A correlation coefficient (r) of 0.850 was obtained. The result indicates that there is a strong positive relationship between pre-service teacher's MET and MOT in electrical and electronics devices. This implies that as pre-service teacher's MET increases, their MOT also increases. Additionally, the SD values denote that the responses of pre-service teachers on both MET and MOT are tightly clustered around the means.

Hypothesis 1

There is no significant relationship between metacognition and academic achievement of Pre-service teachers in electrical and electronics devices in colleges of education.

Data for testing hypothesis 1 are presented in Table 3

Table 3
Simple Regression analysis Result between Pre-service Teacher's Metacognition and Academic Achievement in Electrical and Electronics devices

Model	R	R^2	Df	Adjusted R^2	F	Sig	Decision
Metacognition	.601	.361	2 91	.354	51.328	.001	Rejected

Level of significance 0.05.

Analysis presented in Table 3 shows that the overall regression model was statistically significant, $F(2, 91) = 51.328$, $p = 0.001 < 0.05$, with $R^2 = 0.361$. The null hypothesis, which stated that there is no significant relationship between metacognition and academic achievement in electrical and electronics devices among pre-service teachers in Kano state, is therefore rejected. The R^2 value of 0.354 shows that metacognition explained approximately 35.4% of the variance in pre-service teacher's' Academic Achievement.

Hypothesis 2

There is no significant relationship between metacognition and motivation of pre-service teachers in electrical and electronics devices in colleges of education.

Data for testing hypothesis 2 are presented in Table 4

Table 4
Linear Regression Analysis Result between Pre-service Teacher's Metacognition and Motivation Electrical and Electronics devices

Model	R	R^2	Df	Adjusted R^2	F	Sig	Decision
Metacognition	.850	.722	2 91	.719	236.532	.000	Rejected

Level of significance 0.05.

Table 4 shows that the overall regression model is statistically significant, $F(2, 92) = 236532$, $p = 0.00 < 0.05$, with $R^2 = 0.722$. The null hypothesis, which stated that there is no significant relationship between metacognition and motivation in electrical and electronics devices among pre-service teachers in Kano state, is hereby rejected. The R^2 value of 0.722 shows that metacognition explained approximately 72.2% of the variance in pre-service teacher's motivation.

Discussion of Findings

The aim of this study was to investigate metacognition as correlates of academic achievement and motivation in electrical-electronics devices among pre-service teachers of colleges of education in Kano-Nigeria. To achieve this, six research objectives guided the study.

The findings of research question one revealed that there is a strong positive and statistically significant relationship between pre-service teacher's metacognition and academic achievement in electrical and electronics devices. This implies that the metacognition of pre-service teachers in electrical and electronics devices is related to their academic achievement in such a way that the higher the level of their metacognition, the

higher their academic achievement. This finding is in agreement with the finding of Arami and Wiyarsi (2019) who found that students with higher metacognition levels tended to achieve better academically in Chemistry. It concurs with the discovery of Ogbonnaya et al. (2024), who reported a positive relationship between metacognition and academic performance of students offering biology. Similarly, Oraon (2024) also reported a strong correlation between student's metacognition and their academic achievement in India. Likewise, Owo and Ekwut (2019), found that the relationship between metacognition and students' academic achievement in Chemistry was significant, confirming that metacognition is a critical factor in achieving academic success. These similarities may be attributed to the fact that metacognitive skills enhance effective problem-solving, error detection, and conceptual understanding, which are critical in science and technical subjects

In contrast, Eriyani (2018), in a study carried out on student teachers, in Indonesia, revealed a negative correlation between metacognition and student academic achievement in educational psychology. The disparity may be due to differences in discipline, as educational psychology relies more on theoretical understanding than procedural problem-solving. Other possible reasons include variations in instructional methods, assessment styles, or limited exposure of learners to explicit metacognitive training, which may weaken the observable impact of metacognition on achievement.

The findings of objective two revealed that is a strong positive and statistically significant relationship between pre-service teacher's metacognition and motivation in electrical and electronics devices. This suggests that pre-service teachers with high metacognition are more motivated towards their studies. This outcome aligns with the assertion of Oguz & Ataseven (2016), who found a positive relationship in low level between the metacognitive awareness with both extrinsic and intrinsic motivation of University students in Turkey. Similarly, Farnam and Anjomshoaa (2019) found a significant linear relationship between the components of metacognition (awareness, cognitive strategy, planning and self-assessment), and academic motivation of high school students in Iran. The finding also concurs with the result of Isah et al. (2022), who found a positive and significant relationship exists between senior secondary school students' metacognition and students' academic motivation in Gombe state. In the same vein, Mohammed, Vijaya et al. (2022) found that metacognitive awareness had a significant and strong positive relationship with academic motivation among college students in Malaysia. These perspectives collectively affirm that students with higher metacognition are more likely to develop a growth mindset, maintain focus on their long-term goals, and persist despite setbacks.

Conclusion

Based on the findings of this study, the following conclusions were drawn:

1. Metacognition is a critical determinant of academic success in the Electrical-Electronics Devices course. This means that Pre-service teachers, who possess high awareness and regulation of their cognitive processes, achieve significantly higher academic results than those who do not.
2. There is a strong link between metacognition and motivation. Students who actively regulate their learning strategies are more motivated to engage with the complex technical contents of electrical and electronics devices, suggesting that the will to learn is driven by the skill to learn.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Pre-service teachers should actively cultivate a growth mindset by engaging in self-reflective practices, such as setting specific learning goals and monitoring their comprehension during complex tasks.
2. Lecturers in Colleges of Education should move beyond traditional instruction by explicitly teaching metacognitive strategies, such as modeling thinking aloud during troubleshooting to show students how to regulate cognitive processes.
3. National Commission for Colleges of Education (NCCE) should consider reviewing the Minimum Standards for NCE (Technical) curriculum to explicitly include components of cognitive skills training, ensuring that "learning how to learn" is prioritized alongside technical content.

REFERENCES

Abdelrahman, R. L. (2020). Metacognitive awareness and academic motivation and their impact on academic achievement of Ajman University students. *Heliyon, 6*(9), 43-61.

Arami, M., &Wiyarsi, A. (2019). The student metacognition and achievement in chemistry learning: Correlational study. *Journal of Physics: Conference Series, 10*(7), 271-290.

Bettio, L., Thacker, J., Rodgers, S., Wu, N., & Christie, B. (2022). Hippocampal-prefrontal plasticity underlying metacognitive learning. *Nature Neuroscience, 25*(3), 345-358.

Celik, B. (2022). The effect of metacognitive strategies on self-efficacy, motivation and academic achievement of university students. *Canadian Journal of Educational and Social Studies, 37-55.

Chen, X. (2021). Neural correlates of metacognition in STEM learning. *Journal of Cognitive Neuroscience, 33*(4), 512-525.

Dinsmore, L. D. (2018). Examining the multidimensional role of self-regulated learning in STEM education. *Educational Psychology Review, 30*(1), 1-42.

Efklides, A. (2021). Metacognition and its effects: What can metaconitive experiences tell us about the learning process? *Educational Psychology Review, 23*(4), 551-562.

Egboh, S. (2020). Strategies for improving the teaching of science, technical and vocational education in schools and colleges in Nigeria. *International Journal of Education, Research and Development*, 34-42.

Eriyani, E. (2018). Metacognition and its correlation with academic achievement of student teachers: The case of one private higher education institution. *Indonesian Research Journal in Education*, 78-90.

Fleming, M. S. (2020). Neuroscience of metacognition. *Trends in Cognitive Sciences, 24*(1), 12- 20.

Guay, F., Chanal, J., Ratelle, C. F., & Mash, H. (2019). Intrinsic, identified and controlled types of motivation for school subjects in young elementary school children. *British Journal of Educational Psychology*, 711-735.

Igberadja, S. (2020). Effects of teachers' gender and qualification on students' motivation and performance in vocational technical education. *Journal of Technical Education and Training*, 50-62.

Isah, H., Zubair, A. U., & Garba, S. (2022). Relationship between academic self efficacy, metacognition and academic motivation among senior secondary school students in Gombe Metropolis. *Gombe Journal of Education, 5*(1), 104-117.

Josephine, B., & Osadebamwen, I. (2023). Relationship between self-efficacy and academic achievement of students in Mathematics. *African Journal of Science, Technology and Mathematics Education*, 407-412.

Lawal, H., Hussaini, S., & Saleh, J. (2023). Skills competency among electrical/electronic technology undergraduate students in tertiary institutions in Kano state. *International Journal of Multidisciplinary Research and Development*, 20-25.

Li, X., Wang, Y., & Zhang, G. (2023). Metacognition and achievement in electronics education: An fMRI study. *Journal of STEM Education, 24*(1), 45-60.

Mart, Ç. T. (2022). Can metacognition bring in the ingredients requisite for L2 listening success? *AILA Review*, 262-273.

Mohammed, S. A., Vijaya, S. K., Nazrul, M. A., &Hilmi, F. (2022). Relationship between self- efficacy, Metacognitive awareness and academic motivation among university and college students enrolled in Kuala Lumpur during movement control period (MCO). *Journal of Positive School Psychology, 6*(3), 3362-3374.

Morales, J. (2018). Monitoring the mind: The neurocognitive corelates of metacognition. *Wiley Interdisciplinary Reviews, 9*(1), 567-592.

Murayama, K. (2021). Neuroscience of motivation and metacognition. *Nature Reviews Psychology, 1*(3), 45-59.

National Commission For Colleges of Education (NCCE). (2020). *Nigeria certificate in education minimum standards for vocational and technical education*. National Commission For Colleges of Education.

Nemchinski, V. (2020). Erosion of thermionic cathodes in welding and plasma arc cutting systems. *IEEE Transactions on Plasma Science, 42*(1), 199–215. https://doi.org/10.1109/TPS.2013.2287794

Oguz, A., &Ataseven, N. (2016). The relationship between metacognitive skills and motivation of university students. *Educational Process: International Journal, 5*(1), 54-64.

Ojo, F. T., Ogbonnaya, U. N., Rotimi, P. I., Odukoya, O. M., & Hassan, H. O. (2024). Impact of metacognition and self-efficacy on academic performance of Biology students in Ifo Local Government Area of Ogun State. *AJSTME, 10*(5), 2971-6233.

Oroan, P. (2024). The relationship between Metacognition, self-efficacy and academic achievement among school students. *International Journal of Multidisciplinary Trends, 6*(4), 84-88.

Owo, W. J., &Ikwut, E. F. (2019). Relationship between metacognition, attitude and academic achievement of secondary school Chemistry students in Port Harcourt, Rivers State. *Journal of Research & Method in Education, 5*(6), 6-12.

Ozcan, M. (2021). Factors affecting students' academic achievement according to the education reform journal. *Education Reform Journal*. *12*(5), 146–154

Petrov, G. M., Davidson, A., Gordon, D., Hafizi, B., &Peñano, J. (2021). Thermionic emission of electrons from metal surfaces in the warm dense matter regime. *Physics of Plasmas, 28*(08), 22-34. https://doi.org/10.1063/5.0054955

Salihu, Y., &Nordin, M. (2019). Strategies for evaluation of students' proficiency in. *Jurnal PendidikanTeknologidanKejuruan*, 10-20.

Smith, M. (2023). Advancements in electrical engineering: Shaping the future of technology. *International Research Journal of Engineering Science, Technology and Innovation, 9*(3), 1-3.

Wagaba, F. (2018). Using metacognitive strategies in teaching to facilitate understanding of light concepts among year 9 students. *Research in Science & Technological Education*, 253-272.

Zacolleti, S. (2020). Parents' perceptions of student academic motivation during the COVID-19 lockdown: A cross-country comparison. *Frontiers in Psychology, 7*(2), 17-28.

Zechariah, I., &Tumba, I. (2024). Effect of project-based instructional strategy on Colleges of Education students' achievement, and retention in. *Kwaghe International Journal of Engineering and Information Technology*.

Zohar, A., &Barzilai, S. (2019). Metacognition in science education: Trends, challenges and future directions. *Educational Psychologist, 54*(2), 1-18.