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Leveraging on Neuroscience Based Strategies as Predictor to Improve Learning Outcomes in Social Science Education of Tertiary Institutions in Niger State, Nigeria

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Abstract

This study examined neuroscience-informed instructional strategies as predictors of learning outcomes in Social Science education across tertiary institutions in Niger State, Nigeria. Grounded in Educational Neuroscience and Cognitive Load Theory, the investigation operationalized key constructs—awareness, engagement, and implementation of brain-based pedagogical approaches—and evaluated their influence on students' cognitive ability and retention. A descriptive cross-sectional survey design was employed, with data obtained from 325 respondents drawn from Colleges of Education. Instrument reliability was established with Cronbach's alpha coefficients ranging from 0.71 to 0.82, indicating satisfactory internal consistency. Robust regression modeling was utilized to estimate predictive relationships while mitigating the influence of outliers and heteroscedasticity. The results demonstrate that both awareness and utilization of neuroscience-based instructional strategies exert a statistically significant positive effect on learning outcomes, particularly cognitive ability and retention ($\beta = 0.307$, $p < 0.01$). In addition, student engagement emerges as a significant predictor ($\beta = 0.196$, $p < 0.01$), underscoring the mediating role of active cognitive involvement in enhancing learning efficiency. Interestingly, perceived challenges to the adoption of neuroscience-based strategies are also statistically significant ($\beta = 0.219$, $p < 0.01$), suggesting the presence of adaptive pedagogical responses under contextual constraints. Conversely, general instructional strategies and teachers' attitudes do not exhibit statistically significant predictive power. The findings provide empirical support for the integration of neuroscience-informed pedagogy in tertiary Social Science education. The study therefore recommends the implementation of targeted professional development interventions aimed at enhancing instructors' capacity to design and deliver engagement-driven, cognitively optimized learning experiences.

Keywords

Neuroscience-based instructional strategies;
Learning outcomes;
Student engagement;
Cognitive ability retention;
Social Science education
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1.1 Introduction

Learning outcomes remain a primary indicator of educational effectiveness in higher education systems worldwide. They reflect students' acquisition of disciplinary knowledge, development of higher-order cognitive skills, engagement, and long-term retention of concepts. Globally, underachievement, limited critical thinking, and weak knowledge transfer continue to challenge university education, particularly in disciplines requiring abstract reasoning and contextual application. Contemporary scholarship in educational neuroscience argues that aligning instructional strategies with the brain's mechanisms of attention, memory consolidation, and executive functioning can enhance academic performance (Tokuhama-Espinosa, 2011; Jensen, 2005). Strategies such as spaced practice, retrieval-based learning, multisensory encoding, and metacognitive regulation have been empirically shown to strengthen durable learning and reduce cognitive overload (Dunlosky et al., 2013; Roediger & Karpicke, 2006).

Despite growing global interest in neuroscience-informed pedagogy, its application in higher education remains uneven, especially in low- and middle-income regions like Nigeria. In Sub-Saharan Africa, structural constraints such as large class sizes, limited instructional resources, and lecture-dominated teaching practices hinder learning effectiveness (Abiola & Olayiwola, 2022). Empirical assessments of tertiary education reveal persistent deficits in analytical reasoning and conceptual mastery, particularly in the social sciences fields essential for civic competence and socio-economic development (UNESCO, 2022). Although student-centered pedagogies have gained policy attention, systematic integration of neuroscience-based

strategies into curriculum design and lecturer professional development remains limited (Apeh & Iyiegbuniwe, 2021). Consequently, the translation of neuroscientific insights into classroom practice is still at an emergent stage (Ansari et al., 2012).

In Nigeria, concerns regarding the quality of tertiary education and graduate preparedness remain prominent. Studies consistently report weak knowledge retention, low academic performance, and insufficient critical thinking among undergraduates (Okonkwo, 2020; Adegboye & Bello, 2020). These challenges are particularly pronounced in social science education, where students must interpret abstract models, analyze quantitative and qualitative data, and apply theoretical frameworks to societal issues (Okoro & Uche, 2020). Traditional didactic teaching approaches, characterized by limited cognitive engagement, often fail to support deep learning and knowledge retention (Adebayo & Ogunyemi, 2021). While pedagogical reforms have been introduced, empirical evidence linking neuroscience-informed instructional strategies to measurable learning outcomes in Nigerian tertiary institutions remains sparse.

Neuroscience-based instructional strategies are grounded in principles of cognitive processing, including attention regulation, working memory constraints, dual coding, emotional modulation, and neuroplastic adaptation (Sweller, 2010; Sousa, 2017). By structuring instruction through distributed practice, multimodal representation, and reflective learning, these strategies enhance encoding efficiency and knowledge retention (Zadina, 2014). Emotional engagement and meaningful learning contexts further strengthen memory consolidation and cognitive performance (Immordino-Yang, 2015).

Educational neuroscience therefore provides a theoretical framework for improving instructional effectiveness by aligning pedagogy with brain-based learning mechanisms (Tokuhama-Espinosa, 2018). However, empirical validation of neuroscience-informed pedagogy in Nigerian higher education remains limited, particularly within social science disciplines. Existing studies have predominantly focused on science and technology education, leaving gaps in understanding how brain-based strategies influence learning outcomes in social sciences (Okonkwo, 2020; Adegboye & Bello, 2020).

Against this background, the present study investigates neuroscience-based instructional strategies as predictors of students' cognitive ability and retention in social science education within tertiary institutions in Niger State, Nigeria. Specifically, it examines whether awareness and use of neuroscience-based strategies, the application of neuroscience-based instructional approaches, and student engagement significantly predict improved cognitive ability and retention among students. The study further evaluates the extent to which teachers' attitudes toward neuroscience-based strategies and the challenges associated with their adoption influence students' learning outcomes. In addition, it explores the role of demographic characteristics such as gender, age, and level of study in shaping cognitive ability and retention. By adopting a predictive analytical framework, the study contributes empirical evidence to the emerging field of educational neuroscience in Sub-Saharan Africa (Abiola & Olayiwola, 2022). The findings are expected to inform instructional practice, lecturer training, and higher education policy aimed at

enhancing learning outcomes in resource-constrained educational environments.

2.0 Literature Review

Theoretically, this study is rooted in the educational neuroscience theory and the cognitive load theory that help to explain the underpinnings that has to do with the brain based instructional strategies.

Educational neuroscience Theory bridges the gap between neuroscience and pedagogy by applying findings about brain function to educational practices (Tokuhama-Espinosa, 2011). It emphasizes how the brain learns and retains information, advocating for teaching strategies aligned with neurocognitive processes. The recent advances in cognitive neuroscience have significantly reshaped our understanding of how learning occurs in the brain. Theories such as constructivism and brain-based learning (BBL) emphasize that effective instruction must align with natural brain functions like attention, emotion, memory, and neuroplasticity (Jensen, 2005).

Tokuhama-Espinosa (2011), asserts that, educational neuroscience integrates findings from psychology, biology, and education to create more efficient teaching strategies. Brain-based learning incorporates principles like emotional safety, multi-sensory instruction, pattern recognition, and spaced repetition, which have all been shown to enhance learning outcomes (Sousa, 2017). These approaches are grounded in the understanding that learning is a physiological process influenced by emotions, environment, and relevance.

Cognitive Load Theory explains how the working memory capacity limits learning. Neuroscience supports instructional

strategies that reduce cognitive overload, such as scaffolding and multimodal input (Sweller, 2010). Numerous studies have support the effectiveness of neuroscience-based teaching strategies. Zadina (2014) highlights that, teaching methods will activate multiple brain regions through visuals, movement and storytelling resulting in deeper learning. In a similar vein, Immordino-Yang (2015) have also emphasized strong connection between emotion and cognition, noting that emotionally engaging content leads to better retention. Willis (2010) indicates that, stress-free environments and contextualized learning improve students' executive function, which is crucial for problem-solving in subjects like Economics and Geography. Haimovitz & Dweck's (2016), work on the growth mindset aligns with neuroscience by showing how the belief in one's capacity to learn can physically alter the brain development through neuroplasticity.

Ansari & Grabner (2012) asserts that, the educational neuroscience investigates how insights into brain structure and function can inform our understanding of teaching and learning. This field aims to breach the gap between the brain research and the class room practice by translating insights from cognitive neuroscience into strategies that will enhance the teaching and learning. The neurocognitive foundation emphasizes scaffolding concepts, spaced practice, and emotionally engaging materials.

The choice of educational neuroscience Theory and Cognitive Load Theory over other possible frameworks is based on their relevance and applicability to the study's focus. While neuroscience has been widely applied in Science, Technology, Engineering, and Mathematics (STEM) and literacy instruction,

it is used in social sciences learning and is still emerging. Social Sciences Subjects are often perceived as abstract and difficult due to its reliance on theoretical concepts. Studies have shown that incorporating real-world simulations, interactive models, and emotionally relevant examples can help bridge this abstraction gap (Adu et al., 2022). Adebayo and Ogunyemi (2021) demonstrated that brain-compatible instructional methods significantly improved Economics students' achievement and motivation in Nigerian tertiary institutions. Similarly, Okonkwo (2020), observed that, integrating spaced learning and visual aids into some social classes may improve students' comprehension and interest in theoretical concepts. Therefore, the combination of these two theories provides a robust framework on neuroscience-based instructional strategies as predictors of learning outcomes in social science education in tertiary institutions in Niger State, Nigeria.

Over the past decades, the definition and understanding of Social science education have evolved across generations. Social science education is concerned with the development of critical thinking, citizenship, social awareness, and analytical skills. However, its abstract and interpretive nature often challenges students' comprehension and retention, neuroscience strategies rooted in how the brain learns and can offer tools to make learning in social sciences more engaging, meaningful and effective. This conceptual framework will link neuroscience based instructional strategies with the learning outcomes in social science education using cognitive and educational neuroscience theories as underpinning foundation as explained in the theoretical framework above.

The Neuroscience of Learning highlights the key principles for effective learning. Neuroplasticity is the brain's ability to reorganize itself and supports skill acquisition through repeated practice (Draganski et al., 2004; Correia de Sousa, 2006) A neuroscience strategy is the scientific understanding of brain processes such as attention, memory, motivation, and cognition that affects brain. Thomas et al., (2019) opined that, educational neuroscience explores how findings about brain development and plasticity can inform curriculum design, pedagogy, and learning interventions. The emotion and learning/positive emotions enhances memory retention, while stress impairs cognitive function (Immordino-Yang, 2016). Active learning/engaging multiple senses (visual, auditory, kinesthetic) strengthens neural connections (Mayer, 2017). Apeh & Iyiegbuniwe (2021) investigates brain-based strategies in Abuja secondary schools, and findings revealed a significant increase in motivation when compared to traditional methods. Okatahi et al., (2020) utilizes brain-based learning to measures Economics academic achievement among students and the findings showed a difference of 15.82 points higher on the Economics Achievement Test (EAT), confirming effectiveness.

Neuroscience strategies have increasingly been applied to social science education to enhance student engagement, memory retention, critical thinking, and emotional understanding (Immordino-Yang & Gotlieb, 2017). These strategies bridge brain research with classroom practice and foster learning environments that align with how the brain naturally learns (Zull & Sterling, 2012). Sousa & Rojjanasrirat, (2011) opined that, teaching with visual timelines, storytelling, audio

narratives, and artifacts creates multimodal input, activating more areas of the brain and improving retention. Howard-Jones (2014), says that, the application and integrating movement breaks and encourages healthy habits (e.g., sleep) in learning improves attention and memory retentions.

3.0 Methodology

This study adopted a descriptive survey research design and employed cross-sectional data collected through a well-structured questionnaire based on a four-point Likert scale. Prior to the main survey, a pilot study was conducted using respondents drawn from outside the study area. The reliability of the research instrument was assessed using Cronbach's Alpha technique, and the coefficient obtained was found to be adequate, indicating that the instrument was reliable for the main study. The population of the study comprised 4,251 lecturers and students drawn from two tertiary institutions in Niger State offering Social Science related programmes, namely College of Education (COE), Minna, and Federal College of Education (FCE), Kontagora.

Taro Yamane (1967) sample size determination formula was used from which sample of 366 respondents was selected. The sample was proportionately allocated across the institutions, consisting of 150 students from COE Minna and 205 students from FCE Kontagora. Also, eight (8) lecturers were proportionately sampled, six (6) from COE Minna and two (2) from FCE Kontagora to complement the students' responses and enrich the predictive analysis. The characteristics of the population by institution, department, level, and sample size are presented in Tables 1. Though, only 325

questionnaires were retrieved back from the respondents.

The study employed regression analysis to examine the predictive effect of neuroscience-based instructional strategies on learning outcomes in Social Science education. The econometric model is specified as follows: $LOi/cari = (\beta_0 + \beta_1aunbsi + \beta_2nbisi + \beta_3sei + \beta_4tanbsi + \beta_5canbsi + \beta_6agi + \beta_7geni + \beta_8lsi + \epsilon)$...3.1. Where aunbsi

is Awareness and Use of Neuroscience-Based Strategies, nbisi is Neuroscience-Based Instructional Strategies, sei is Student Engagement, tanbsi is Teachers' Attitude toward Neuroscience-Based Strategies, canbsi is Challenges to Adoption of Neuroscience-Based Strategies, agi is Age of the respondent, geni is the gender of the respondent, lsi is Level of study, ϵ is error term.

Table 1: List of Institutions; Departments, Students/Lecturers Population and Sample Size

Inst. Name	Depts	100L	200L	300L	Total	S. Size	Lec. Popl	S. size
COE Minna	Economics	151	189	228	568	49	16	01
	Geography	07	12	17	36	03	19	02
	Social Stds	226	260	339	825	71	14	01
	History	21	11	10	42	04	06	00
	Islamic Std	63	75	99	237	20	10	01
	Chrit. Std	07	11	15	33	03	09	01
	Total				1741	150	74	06
FCE K/gora	Economics	120	82	95	297	25	05	00
	Geography	22	20	27	78	07	06	00
	Social Stds	246	215	205	666	57	12	01
	History	28	37	41	106	09	05	00
	Islamic Std	62	40	43	145	12	07	01
	Chrit. Std	10	9	8	27	02	05	00
	Political Sc	380	325	375	1081	93	06	00
Total				2400	205	36	02	

Source: Exams Office COE Minna and Dean's Office FCE K/gora, 2026

4.0 Results Presentation and Discussion of Findings

Reliability Test

Table 4.1: Descriptive Statistics of Reliability

Measure	Numbers of Items	Cronbach's Alpha
Awareness and Use of Neuroscience-Based Strategies	5	0.73
Neuroscience-Based Instructional Strategies	6	0.81
Student Engagement	4	0.72
Cognitive Ability and Retention	4	0.71
Teachers' Attitude toward Neuroscience-Based Strategies	4	0.76
Challenges to Adoption of Neuroscience-Based Strategies	5	0.82

Source: Authors' Computation, 2026

Table 4.1 reports the Cronbach's alpha coefficients for all study constructs. The reliability values range from 0.71 to 0.82, with Awareness and Use of Neuroscience-Based Strategies ($\alpha = 0.73$), Neuroscience-Based Instructional Strategies ($\alpha = 0.81$), Student Engagement ($\alpha = 0.72$), Cognitive Ability and Retention ($\alpha = 0.71$), Teachers' Attitude ($\alpha =$

0.76), and Challenges to Adoption ($\alpha = 0.82$). Since all coefficients exceed the recommended 0.70 threshold, the measures demonstrate satisfactory internal consistency. This indicates that the scales are psychometrically reliable and suitable for subsequent regression analysis.

Table 4.2: Respondents' Demographic Profile (N = 325)

Variables		Frequency	Percentage
Age	<18	15	5
	18- 22	125	38
	23- 27	135	42
	>28	50	5
Gender	Male	129	40
	Female	196	60
Institution	COEMX	154	47
	FCE KNT	171	53
Respondent Status	Student	318	98
	Teacher Educator	7	2
Courses of Study	Economics	76	23
	Geography	12	4
	Social Studies	119	37
	History	12	4
	Islamic Studies	33	10
	Christian Rel. Std.	6	1
	Political Science	67	21
Level of Study	NCEI	27	8
	NCEII	186	59
	NCEIII	105	33
Years of Teach. Exp.	<18	6	86
	>15	1	14

Source: Authors' Computation, 2026

Table 4.2 presents the demographic characteristics of the 325 respondents. On age distribution, (42%), were within the age bracket of 23–27 followed by 18-22 years at (38%) suggesting that most participants were within the typical age range for tertiary education. Only a small proportion were below 18 years (5%) while above 28 years was (5%).

On gender, female respondents constituted 60% of the sample, while males were 40%. Distribution by institutions shows that 53% of respondents were from Federal College of Education, Kontagora (FCE KNT), while 47% were from College of Education, Minna (COEMX). On respondent's status, 98% of participants were students, while only 2% were

teacher educators. On the course of study, Social Studies had the highest representation (37%), Economics (23%) Political Science (21%). While other disciplines such as Geography, History, Islamic Studies, and

Christian Religious Studies had smaller proportions.

On the level of study, most respondents were in NCE II (59%), followed by NCE III (33%), while NCE I accounted for only 8.

Table 4.3: Robust Regression Estimates

Cognitive Ability and Retention	Coefficient /P-value
Awareness and Use of Neuroscience-Based Strategies	.307272 (0.000***)
Neuroscience-Based Instructional Strategies	.026949 (0.666)
Student Engagement	.196000 (0.000***)
Teachers' Attitude toward Neuroscience-Based Strategies	-.037477 (0.489)
Challenges to Adoption of Neuroscience-Based Strategies	.219391 (0.000 ***)
Gender	-.1465908 (0.001**)
Age	.0375332 (0.135)
Level of study	.0172308 (0.624)
Obs 325	
Prob 0.0000	
R ² 0.4519	

Notes: P values are in parentheses, significance level: *10%; **5%; ***1%

Source: Field Survey, 2026 using Stata/SE 14.2

Table 4.3 presents the results of the robust regression analysis examining the predictive effect of neuroscience-based instructional strategies on cognitive ability and retention (learning outcome). The model is statistically significant (Prob > F = 0.0000), indicating that the explanatory variables jointly predict

cognitive ability and retention. The R² value of 0.4519 suggests that approximately 45.19% of the variation in cognitive ability and retention is explained by the independent variables included in the model. This reflects moderate explanatory power.

Awareness and use of neuroscience-based strategies had a positive and statistically significant coefficient ($\beta = 0.307272$, $p < 0.01$). This implies that an increased awareness and utilization of neuroscience-based strategies significantly enhance students' cognitive ability and retention. This variable appears to be one of the strongest predictors in the model. Neuroscience-based instructional strategies, although positive ($\beta = 0.026949$), is not statistically significant ($p = 0.666$). This suggests that mere presence of such strategies, without proper awareness or effective engagement, may not independently predict improved cognitive outcomes.

Student engagement shows a positive and highly significant relationship ($\beta = 0.196000$, $p < 0.01$). This shows that higher levels of engagement substantially will improve cognitive ability and retention, reinforcing the mediating role of engagement in the learning process.

Teachers' attitude toward neuroscience-based strategies is negative but statistically insignificant ($\beta = -0.037477$, $p = 0.489$), revealing that attitude alone does not directly influence students' cognitive outcomes unless translated into practical implementation.

Interestingly, challenges to adoption of neuroscience-based strategies shows a positive and significant coefficient ($\beta = 0.219391$, $p < 0.01$). This may imply that where challenges were recognized and addressed, cognitive outcomes improve. Alternatively, it may reflect measurement or perception effects that require further interpretation. Gender is negative and statistically significant ($\beta = -0.1465908$, $p < 0.05$), implying that gender differences exist in cognitive ability and

retention. The negative sign suggests that one gender category (depending on coding) performs lower relative to the reference group.

Age and level of study were not statistically significant, implying that differences in cognitive ability and retention were not substantially explained by these demographic factors in this model.

Discussion of Findings

The regression results revealed that awareness and the use of neuroscience-based strategies significantly and positively predict cognitive ability and retention ($\beta = 0.307$, $p < 0.01$). These findings aligned strongly with Educational Neuroscience Theory which posits that, when instructional approaches are consciously aligned with brain-based principles such as spaced practice, emotional relevance, and multisensory encoding, learning efficiency improves. The result supports the argument that knowledge and deliberate application of neurocognitive principles enhance encoding, consolidation, and retrieval processes.

In contrast, the variable measuring general neuroscience-based instructional strategies was positive but statistically insignificant ($\beta = 0.027$, $p > 0.05$). This suggest that the mere presence of such strategies may not be sufficient to influence cognitive outcomes unless accompanied by deliberate awareness and structured implementation. It is clear from a Cognitive Load Theory perspective, that instructional strategies must be intentionally designed to reduce extraneous load and optimize working memory capacity. Unstructured or superficial adoption may fail to produce measurable gains.

Student engagement emerged as a significant positive predictor of cognitive ability and retention ($\beta = 0.196$, $p < 0.01$). This finding is theoretically consistent with neuroscience evidence emphasizing the interaction between emotion, attention, and cognition. Engagement enhances dopamine activation and attentional focus, thereby strengthening neural pathways associated with memory formation. The result corroborates Immordino-Yang's theoretical position that emotional and cognitive processes are inseparable in effective learning. This also suggests that engagement may function as a mediating mechanism through which neuroscience-based strategies influence learning outcomes. When instructional strategies stimulate curiosity, emotional involvement, and active participation, deeper cognitive processing occurs, leading to improved retention.

Teachers' attitude toward neuroscience-based strategies was statistically insignificant ($\beta = -0.037$, $p > 0.05$). It is clear that positive disposition alone does not directly translate into improved student cognitive outcomes. Theoretically, this underscores the distinction between belief and behavioral implementation. Educational neuroscience emphasizes practical alignment between teaching practice and brain function; therefore, attitude without consistent classroom application may not yield observable effects.

Interestingly, challenges to adoption showed a positive and significant coefficient ($\beta = 0.219$, $p < 0.01$). Alternatively, this may suggest that lack of awareness on implementation stimulates adaptive strategies or compensatory instructional adjustments. It may also indicate that institutions confronting challenges were actively engaging with reform

processes, thereby indirectly improving learning outcomes. However, this finding warrants cautious interpretation and further investigation.

Gender was statistically significant ($\beta = -0.147$, $p < 0.05$), suggesting the presence of gender-related differences in cognitive ability and retention. The direction of the coefficient depends on coding but indicates systematic variation across groups. This aligns with some literature suggesting differential engagement patterns or learning experiences across genders.

Age and level of study were not statistically significant predictors, indicating that cognitive ability and retention were more strongly influenced by instructional and engagement factors than by demographic characteristics in this context.

Conclusion

Learning is multidimensional, thereby, making it versatile to all ages. Neuroscience based strategy if well utilized, has the capacity to change classroom practices profoundly by aligning teaching methods with the biological mechanism of the brain. This study examined the predictive effect of neuroscience-based instructional strategies on learning outcomes, specifically the cognitive ability and retention in social science education within the tertiary institutions in Niger State, Nigeria. The findings provided empirical support for the relevance of neuroscience-informed pedagogy in improving academic outcomes in resource-constrained higher education contexts.

Time has proved the weakness of traditional teaching methods that has practically ignore biologically wiring over neuroscience strategy that has the ability of translating complex

findings into practical strategies that teacher educators can implement effectively. Teacher educators are key to this change hence, every available vehicle should be maximized by all stake holders in implying these strategies making them more impactfull among learners.

Recommendations

The recommendations are derived directly from the statistically significant predictors as identified in the regression analysis.

i. Enhance Practical Application of Neuroscience-Based Strategies:

Tertiary institutions should strengthen training programs that emphasize the practical use of neuroscience-based strategies such as spaced learning and multimodal instruction. This should be driven by regulatory bodies and higher institutions.

ii. Promote Student Engagement in Teaching:

Lecturers should adopt interactive and learner-centered approaches, including discussions, simulations, and collaborative tasks, to improve cognitive outcomes. Institutions should embed engagement in teaching guidelines.

iii. Address Implementation Constraints:

Institutions and policymakers should tackle barriers such as large class sizes, limited resources, and inadequate training by providing targeted support and monitoring systems.

iv. Adopt Gender-Sensitive Teaching Approaches:

Institutions should implement inclusive teaching strategies and targeted support to address gender-based differences in learning outcomes.

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