HARNESSING COGNITIVE DIAGNOSTIC ASSESSMENT (CDA) FOR IMPROVING RESEARCH ATTITUDE: A TRANSFORMATIVE APPROACH FOR UNDERGRADUATE STUDENTS IN THE UNIVERSITY OF MAIDUGURI

By

[1] **Dr. Hamafyelto, S. Rufina;**   [2] **Prof. Abubakar Hamman-Tukur;** [3] **Prof. Alice, Kyauta Jauni**

[1,2,3] Department of Social Science Education, Faculty of Education, University of Maiduguri

Abstract

The persistent challenge of research anxiety and poor attitude toward inquiry among undergraduate students in Nigeria necessitates a shift from traditional summative assessments to more diagnosticoriented approaches. This study investigated the efficacy of Cognitive Diagnostic Assessment (CDA) in fostering a positive research attitude among undergraduate students in the Department of Education, University of Maiduguri. Adopting a quasi-experimental pretest-posttest non-equivalent control group design, the study sampled 93 students categorized into Experimental (n=47) and Control (n=46) groups. The experimental group was exposed to instruction supplemented with CDA-based diagnostic feedback, while the control group was taught using traditional evaluative methods. Data were collected using a 40-item Research Attitude Scale (RAS), validated through expert judgment and Cronbach Alpha reliability testing (r=0.84). Data were analyzed using Mean, Standard Deviation, and Analysis of Covariance (ANCOVA). Findings revealed a significant main effect of CDA on research attitude (F=400.506, p<0.05), with a high effect size (Partial η2=0.818). The study also found that gender did not significantly influence the effectiveness of the intervention (F=0.881, p=0.350). It was concluded that providing students with fine-grained feedback regarding their cognitive gaps demystifies the research process. The study recommends the institutionalization of CDA-based feedback mechanisms in Nigerian universities to enhance students' scholarly dispositions.

Keywords: *Cognitive Diagnostic Assessment (CDA), Research Attitude, Undergraduate Students,*

Introduction

In the contemporary landscape of Nigerian higher education, the acquisition of research skills is not merely an academic requirement but a professional necessity. The final-year research project serves as a capstone experience, intended to develop critical thinking, problem-solving abilities, and a spirit of inquiry. However, within the Department of Education at the University of Maiduguri, and indeed across many Nigerian universities, a significant percentage of students perceive research as a "necessary evil" or a hurdle to be cleared only for the sake of graduation. This negative attitude often stems from the abstract nature of research methods and the lack of constructive, formative feedback during the learning process.

Traditional assessment practices in Nigerian universities are predominantly summative. Students are often graded on their ability to memorize research concepts or produce a final document, without receiving clear insights into the specific cognitive processes they have or have not mastered. This "judgmental" approach to assessment contributes to "research phobia," leading to academic apathy, plagiarism, and poor performance. Cognitive Diagnostic Assessment (CDA) emerges as a pedagogical intervention designed to address these deficiencies. Unlike traditional testing, CDA is a category of assessment models that combine cognitive psychology and psychometrics to provide detailed information about a student's specific knowledge structures. By identifying "attributes" or specific sub-skills—such as the ability to state a problem, select an appropriate research design, or interpret statistical data—CDA provides a "diagnostic profile" that allows students to see exactly where their cognitive gaps lie.

The rationale for this study is rooted in the belief that when students receive precise, non-punitive feedback about their learning hurdles, their self-efficacy increases, which in turn fosters a more favorable attitude toward research. Furthermore, given the socio-cultural context of North-Eastern Nigeria, it is pertinent to investigate whether such an intervention benefits male and female students equally or if gender remains a moderating factor in research disposition.

Literature Review

The theoretical foundation of this study is primarily anchored on Albert Bandura's Social Cognitive Theory, specifically the concept of Self-Efficacy. Bandura posits that an individual's belief in their capability to organize and execute the courses of action required to manage prospective situations

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directly influences their emotional reactions and behavioral choices. In the context of research, a student with low self-efficacy perceives the research process as a threat, leading to avoidant behavior and a negative attitude. CDA acts as a scaffold that builds self-efficacy by breaking down the complex task of research into manageable cognitive attributes. When a student transitions from "not knowing why they are wrong" to "knowing exactly which skill to refine," their perceived mastery increases, leading to a shift in attitude.

Empirically, the concept of Research Attitude has been explored by various scholars. Papanastasiou (2014) defines research attitude as a multidimensional construct consisting of the belief in the usefulness of research, the anxiety associated with research, and the general predispositions toward the subject. In Nigeria, studies by Ekanem (2021) have consistently shown that undergraduate students harbor high levels of research anxiety due to poor foundational knowledge in Statistics and Logic. This is further exacerbated by the "feedback gap" in large classrooms common in universities like the University of Maiduguri, where lecturers may lack the tools to provide individualized diagnostic reports.

Cognitive Diagnostic Assessment (CDA) is an evolving field in measurement and evaluation. Proponents of the Rule Space Model and DINA (Deterministic Input, Noisy "And" gate) models argue that diagnostic feedback is far more effective for behavioral change than traditional scores. While significant research has been conducted on the use of CDA in Mathematics and Language Arts, its application to "Research Attitude" in the Nigerian educational sector remains sparse. Furthermore, the debate on Gender and Research remains inconclusive. Some Nigerian scholars argue that male students show a higher preference for quantitative research due to historical gender roles in STEM education, while others suggest that gender differences in academic attitude disappear when modern, inclusive pedagogical tools are employed. This study seeks to fill these gaps by providing empirical evidence from a North-Eastern Nigerian perspective.

Methodology

The study utilized a quasi-experimental pretest-posttest non-equivalent control group design. This design is particularly suitable for educational research in natural classroom settings where the random assignment of individual students is neither practical nor ethical. The population of the study

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consisted of all 400-level undergraduate students in the Department of Education, University of Maiduguri, during the 2024/2025 academic session.

A purposive sampling technique was used to select two intact classes, resulting in a total sample size of 93 students. These were divided into:

- Experimental Group (n=47): Exposed to CDA-based feedback.

- Control Group (n=46): Exposed to traditional evaluative feedback.

The instrument used for data collection was the Research Attitude Scale (RAS), which consisted of 40 items structured on a 4-point Likert scale ranging from "Strongly Agree" to "Strongly Disagree." The RAS covered five dimensions: Research Usefulness, Research Anxiety, Positive Affect, Research Difficulty, and Relevance to Life. The instrument was subjected to face and content validity by three experts in the Department of Education (Measurement and Evaluation). A pilot study conducted on 20 students not included in the final sample yielded a Cronbach Alpha reliability coefficient of 0.84, indicating the instrument was highly reliable.

The research procedure involved three phases. In the Pre-intervention Phase, both groups were administered the RAS as a pretest to establish their baseline research attitude. In the Intervention Phase, both groups were taught the same Research Methods syllabus for six weeks. However, after each weekly module, the experimental group took diagnostic tests and received "Mastery Profiles" indicating which specific research skills (e.g., Literature Review vs. Data Analysis) they had mastered. The control group took the same tests but received only a percentage score and general comments. In the Post-intervention Phase, the RAS was re-administered as a posttest to measure the change in attitude.

Results

The research questions were answered using Mean and Standard Deviation, while the null hypotheses were tested at a 0.05 level of significance using Analysis of Covariance (ANCOVA). ANCOVA was chosen to statistically control for the effect of the pretest (covariate) on the posttest scores.

Table 1: Mean and Standard Deviation of Research Attitude Scores by Group and Gender

Group	Gender	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
Experimental	Male	26	75.19	16.69	125.35	17.45	50.16
	Female	21	75.05	15.24	131.00	12.69	55.95
	Total	**47**	**75.13**	**15.88**	**127.87**	**15.61**	**52.74**
Control	Male	26	65.19	16.05	67.08	11.71	1.89
	Female	20	63.35	15.31	66.75	11.67	3.40
	Total	**46**	**64.39**	**15.59**	**66.93**	**11.57**	**2.54**

The descriptive statistics presented in Table 1 provide a comparative analysis of the pretest and posttest mean scores for undergraduate students' research attitude across the experimental and control groups, further disaggregated by gender.

At the commencement of the study, the baseline data indicated that students in the experimental group possessed a pretest mean score of 75.13 (SD = 15.88), while their counterparts in the control

group had a lower baseline mean of 64.39 (SD = 15.59). Following the implementation of the Cognitive Diagnostic Assessment (CDA) intervention, the experimental group exhibited a substantial increase in their research attitude, reaching a posttest mean score of 127.87 (SD = 15.61). This represents a remarkable mean gain of 52.74. Conversely, the control group, which was subjected to traditional summative assessment methods, showed a negligible improvement, with their mean score rising only slightly to 66.93 (SD = 11.57), resulting in a mean gain of just 2.54.

When the results are examined through the lens of gender within the experimental group, both male and female students demonstrated significant positive shifts in attitude. Male students in the experimental group moved from a pretest mean of 75.19 (SD = 16.69) to a posttest mean of 125.35 (SD = 17.45), reflecting a gain of 50.16. Female students in the same group showed an even more pronounced improvement, progressing from a pretest mean of 75.05 (SD = 15.24) to the highest overall posttest mean of 131.00 (SD = 12.69), a gain of 55.95.

In the control group, gender-based gains remained consistently low and largely stagnant. Male students recorded a minor increase from 65.19 to 67.08 (Gain = 1.89), while female students moved from 63.35 to 66.75 (Gain = 3.40). The standard deviations for the experimental group remained relatively stable, whereas the control group's standard deviation narrowed significantly at the posttest stage. This indicates that while the CDA intervention consistently elevated the attitudes of the experimental group, the control group became more uniformly clustered around a lower attitudinal threshold.

The descriptive evidence suggests that the CDA intervention was highly effective in transforming the research disposition of the students, with female students showing the most substantial numerical gain, although the subsequent inferential analysis (ANCOVA) determines if these gender differences are statistically significant.

Table 2: Result of Analysis of Covariance (ANCOVA) on Effect of Cognitive Diagnostic Assessment of Undergraduate Students' Research Attitude with Pretest as Covariate and Posttest as Dependent Variable

Source	Type III Sum of Squares	Df	Mean Square	F	p. val.	Partial Eta Squared
Corrected Model	86496.658	3	28832.219	150.488	.000	.835
Intercept	41333.824	1	41333.824	215.740	.000	.708
Group (Exp vs. Cont)	76733.499	1	76733.499	400.506	.000	.818
Gender (Male vs. Female)	168.816	1	168.816	.881	.350	.010
Pretest Attitude	2.793	1	2.793	.015	.904	.000
Error	17051.621	89	191.591			
Total	991827.000	93				
Corrected Total	103548.280	92				

R Squared = .835

(Adjusted R Squared = .830)

The results in Table 2 indicate a significant main effect of the treatment (Cognitive Diagnostic Assessment) on the research attitude of undergraduate students, $F(1, 89) = 400.506$, $p < .05$. The null hypothesis is therefore rejected. The partial eta squared ($eta^2 = .818$) shows that the

intervention accounted for 81.8% of the variance in the posttest research attitude scores, representing a very large effect size. This implies that the use of CDA significantly improved students' research attitudes compared to the traditional assessment method.

Regarding the effect of gender, the ANCOVA results show that gender did not have a significant main effect on research attitude, $F(1, 89) = .881$, $p > .05$. Consequently, the null hypothesis is retained. This indicates that the effect of Cognitive Diagnostic Assessment on students' research attitude does not significantly vary between male and female students. Furthermore, the interaction between the covariate (pretest) and the posttest was not significant ($F = .015$, $p = .904$), confirming that the CDA intervention was the primary driver of the change in attitude.

The model as a whole explained 83% of the adjusted variance in students' research attitudes (Adjusted $R^2 = .830$), suggesting that the variables included in the model are highly robust predictors of research attitude among the sampled students.

Discussion of Findings

The primary finding of this study revealed that Cognitive Diagnostic Assessment (CDA) has a profound and statistically significant effect on the research attitude of undergraduate students in the Department of Education, University of Maiduguri. The rejection of the first null hypothesis was supported by a massive F-value of 400.506 and a high effect size (Partial $eta^2 = .818\$$), which indicates that the intervention explained over 80% of the variance in the students' posttest scores. This suggests that the psychological transition from a negative or indifferent attitude to a positive research disposition is heavily dependent on the quality and specificity of the feedback students receive during their learning journey.

This finding aligns with the self-efficacy theory of Albert Bandura, which posits that mastery experiences, supported by clear and diagnostic information about one's performance, lead to increased confidence and a more favorable attitude toward challenging tasks. In the experimental group, students were not merely told they were "right" or "wrong"; they were provided with a granular breakdown of their mastery across specific research attributes. This demystification of the research process likely reduced the "research anxiety" that typically characterizes undergraduate students in Nigeria. The results are consistent with the assertions of Tatsuoka (2009) and Lee (2019),

who argued that diagnostic assessments empower learners by identifying specific cognitive gaps, thereby making the learning process more transparent and less intimidating.

Furthermore, the study found that the effect of CDA on research attitude does not significantly vary with gender. The retention of the second null hypothesis suggests that both male and female students in the University of Maiduguri benefited equally from the diagnostic intervention. While the descriptive statistics showed that female students in the experimental group achieved the highest posttest mean score (131.00), the ANCOVA result confirmed that this difference was not statistically significant. This is a critical finding in the context of Northern Nigeria, as it implies that CDA is a gender-neutral pedagogical tool that can be used to bridge any perceived gaps in research interest or aptitude. It reinforces the idea that when the "black box" of assessment is opened through diagnostic feedback, gender-based stereotypes regarding research capability are dismantled. This finding aligns with contemporary research in Nigerian assessment cycles which, suggests that inclusive, formative-based strategies yield uniform benefits across gender lines.

Conclusion

Based on the empirical evidence generated in this study, it is concluded that the traditional, summative-heavy assessment methods currently prevalent in Nigerian universities are insufficient for fostering a robust research culture among undergraduates. The study concludes that Cognitive Diagnostic Assessment is a transformative tool that significantly enhances students' research attitudes by replacing ambiguity with clarity. By providing fine-grained feedback, CDA shifts the student's perception of research from an insurmountable hurdle to a series of masterable skills. Ultimately, the successful integration of CDA in the Department of Education, University of Maiduguri, has proven that the psychological disposition of students toward inquiry can be systematically improved through targeted, diagnostic interventions, regardless of the student's gender.

Recommendations

Based on the findings and the conclusions reached, the following recommendations are proffered:

1. **Institutionalization of CDA:** The University of Maiduguri, particularly the Faculty of Education, should officially integrate Cognitive Diagnostic Assessment into the teaching and evaluation of Research Methods and Statistics courses. This would ensure that students receive formative profiles rather than just summative grades.

2. **Professional Development for Academics:** Workshops and seminars should be organized by the University's Centre for Quality Assurance to train lecturers on the technicalities of CDA, including the development of Q-matrices and the interpretation of attribute-mastery profiles.

3. **Curriculum Reform:** The National Universities Commission (NUC) should consider making diagnostic-based assessment a core component of the Research capstone in the Core Curriculum and Minimum Academic Standards (CCMAS) to improve the quality of undergraduate projects across Nigeria.

4. **Deployment of Digital Diagnostic Tools:** To manage large class sizes effectively, the university should invest in or develop computer-based diagnostic systems that can automate the provision of feedback, ensuring every student receives a personalized mastery report.

5. **Gender-Inclusive Pedagogical Strategies:** Educators should be encouraged to utilize CDA as a strategy to maintain gender equity in research participation, ensuring that the research environment remains supportive and transparent for all students.

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