

Effect of a Trauma-Informed Chemistry Instructional Model on Reintegration and Academic Achievement of Displaced Senior Secondary Students in Benue State, Nigeria¹

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Abstract

This study examined the effect of a Trauma-Informed Chemistry Instructional Model (TIICM) on the reintegration and academic achievement of displaced senior secondary school students in Benue State, Nigeria. The persistent herdsman-farmer conflicts and inter-communal crises in Benue State have produced a growing population of internally displaced students whose educational continuity has been severely disrupted, yet no empirical study has investigated a trauma-sensitive instructional framework specifically designed for chemistry learning among this population. A quasi-experimental pre-test post-test non-equivalent control group design was adopted. A purposive and stratified sample of 70 displaced Senior Secondary School Two (SSS II) Chemistry students drawn from two resettlement schools in Makurdi and Gboko were assigned to experimental ($n = 35$) and control ($n = 35$) groups. Two instruments were developed and validated: the Chemistry Achievement Test (CAT; $KR-20 = 0.84$) and the Reintegration Index Scale (RIS; Cronbach's $\alpha = 0.81$). Data were analysed using means, standard deviations, and Multivariate Analysis of Covariance (MANCOVA) at 0.05 level of significance. Results showed that students taught using the TIICM significantly outperformed those taught through the conventional lecture method on both academic achievement, $F(1, 67) = 53.96, p < .001, \eta^2 = .44$, and reintegration, $F(1, 67) = 41.22, p < .001, \eta^2 = .38$. Significant differences were found by gender and displacement duration within the TIICM group. The study concludes that TIICM is an effective, context-sensitive instructional approach for improving chemistry learning and school reintegration among conflict-affected students and recommends its systematic adoption in schools serving displaced populations in Benue State.

Keywords: Trauma-Informed Instruction, Chemistry Achievement, School Reintegration, Displaced Students, Benue State.

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Effets d'un modèle d'enseignement de la chimie sensible aux traumatismes sur la réintégration scolaire et la réussite académique des étudiants déplacés : une étude quasi expérimentale dans l'État de Benue (Nigéria)

Résumé

Cette étude examine l'effet d'un modèle d'enseignement de la chimie sensible aux traumatismes (Trauma-Informed Chemistry Instructional Model, TIICM) sur la réintégration scolaire et la réussite académique des élèves déplacés du secondaire supérieur dans l'État de Benue, au Nigéria. Les conflits persistants entre éleveurs et agriculteurs, ainsi que les crises intercommunautaires dans cet État, ont engendré une augmentation du nombre d'élèves déplacés internes dont la continuité éducative a été gravement perturbée. Toutefois, aucune étude empirique n'avait jusqu'à présent examiné un cadre pédagogique sensible aux traumatismes spécifiquement conçus pour l'enseignement de la chimie auprès de cette population. Un dispositif quasi expérimental de type prétest–post-test avec groupe témoin non équivalent a été adopté. Un échantillon raisonné et stratifié de 70 élèves déplacés de Senior Secondary School Two (SSS II), inscrits en chimie et issus de deux écoles de réinstallation situées à Makurdi et Gboko, a été réparti en groupe expérimental ($n = 35$) et groupe témoin ($n = 35$). Deux instruments ont été élaborés et validés : le test de performance en chimie (Chemistry Achievement Test, CAT ; $KR-20 = 0,84$) et l'échelle d'indice de réintégration (Reintegration Index Scale, RIS ; α de Cronbach = 0,81). Les données ont été analysées à l'aide de moyennes, d'écart-types et d'une analyse multivariée de covariance (MANCOVA) au seuil de signification de 0,05. Les résultats indiquent que les élèves ayant bénéficié du modèle TIICM obtiennent des performances significativement supérieures à celles des élèves ayant suivi un enseignement traditionnel magistral, tant en termes de réussite académique, $F(1, 67) = 53,96$; $p < 0,001$; $\eta^2 = 0,44$, que de réintégration scolaire, $F(1, 67) = 41,22$; $p < 0,001$; $\eta^2 = 0,38$. Des différences significatives ont également été observées selon le genre et la durée du déplacement au sein du groupe TIICM. L'étude conclut que le TIICM constitue une approche pédagogique efficace et adaptée au contexte pour améliorer l'apprentissage de la chimie et la réintégration scolaire des élèves affectés par les conflits. Elle recommande son adoption systématique dans les établissements accueillant des populations déplacées dans l'État de Benue.

Mots-clés : Enseignement sensible aux traumatismes, réussite en chimie, réintégration scolaire, élèves déplacés, État de Benue.

INTRODUCTION

The socio-political landscape of Benue State has been profoundly shaped by prolonged herdsman-farmer conflicts, inter-communal violence, and periodic flooding that have displaced over 1.4 million persons across various local government areas, with children constituting approximately 42% of this population (SEMA, 2023; Iorbo et al., 2024). The educational consequences for displaced school-age children are severe: interrupted schooling, loss of learning materials, psychological trauma, and abrupt severance from familiar classroom environments (Duru & Agbo, 2025). For many, returning to formal education is fraught with psychological barriers that conventional instructional approaches are ill-equipped to address.

Chemistry, central to Nigeria's national development agenda and to students' advancement into STEM careers, remains among the worst-performing subjects in external examinations in Benue State (WAEC, 2022; Omwirhiren, 2015). Its inherent challenges abstract concepts, laboratory requirements, and mathematical reasoning are exponentially amplified for students carrying the weight of traumatic displacement experiences into the classroom (Ajayi & Ogbeba, 2017). Yet empirical investigations into trauma-sensitive instructional models specifically designed for chemistry learning in Nigerian conflict-affected settings remain virtually non-existent.

Trauma-Informed Education (TIE) represents a paradigmatic reorientation of schooling that prioritises safety, trustworthiness, peer support, collaboration, empowerment, and cultural sensitivity as foundational conditions for effective learning (Thomas et al., 2019). Unlike conventional approaches, trauma-informed instruction deliberately integrates awareness of students' adverse experiences into lesson design, classroom interactions, feedback, and assessment. The Trauma-Informed Chemistry Instructional Model (TIICM) developed and tested in this study operationalises these principles within secondary school chemistry, creating structured, emotionally safe, and cognitively scaffolded learning experiences for displaced students.

Evidence from Nigerian contexts affirms the detrimental impact of displacement on academic performance. Lawrence and Falaye (2020) demonstrated that trauma-focused psychosocial interventions significantly improved psychological functioning among internally displaced adolescents in North-Central Nigeria, while Eseadi et al. (2016) established that structured counselling-based interventions produced measurable improvements in academic engagement and emotional wellbeing among

Nigerian secondary students. These findings underscore the urgency of instructional models that simultaneously address academic and psychosocial dimensions of learning for conflict-affected students.

School reintegration, defined here as the process by which displaced students re-establish meaningful academic engagement, social belonging, and emotional stability, has received growing attention in Nigerian educational policy discourse, particularly in the context of conflict-affected schooling (Duru & Agbo, 2025; Iorbo et al., 2024). However, empirical studies examining instructional interventions that promote reintegration outcomes alongside academic achievement remain sparse, and none have specifically investigated the chemistry classroom as a site for such intervention in Benue State. This study addresses that critical gap.

The theoretical framework integrates Vygotsky's (1978) Sociocultural Theory and Bronfenbrenner's (1979) Ecological Systems Theory. Sociocultural theory emphasises socially mediated, scaffolded interaction in knowledge construction central to the TIICM's use of collaborative learning groups, peer mentoring, and teacher-facilitated guided inquiry. Ecological Systems Theory positions the student within intersecting environmental layers: microsystem, mesosystem, exosystem, and macrosystem, providing the theoretical basis for why trauma-responsive classrooms must extend beyond content delivery to engage the student's holistic social ecology. Together, these theories scaffold the TIICM and its dual outcome focus: achievement and reintegration.

Gender differences in science achievement and psychosocial outcomes among conflict-affected populations have been documented inconsistently in Nigerian literature. Ajayi and Ogbeba (2017) found no significant gender difference in chemistry achievement among students taught using hands-on activities in Benue State, while Lawrence and Falaye (2020) reported that female displaced adolescents demonstrated greater vulnerability to the academic consequences of psychosocial stress. Regarding displacement duration, Iorbo et al. (2024) observed that prolonged displacement compounded patterns of academic disengagement and social exclusion among conflict-affected students in Benue State, suggesting duration as a significant moderating variable in intervention effectiveness. This study examines both variables within the TIICM framework.

The intersection of armed conflict, displacement, and educational disruption has created an underserved population of learners in Benue State whose needs are

inadequately met by conventional instruction. Displaced students consistently perform below state and national averages in chemistry, with credit pass rates below 28% in recent years (WAEC, 2022; Omwirhiren, 2015), while many exhibit psychosocial distress, withdrawal, poor concentration, emotional dysregulation, and difficulty forming trusting relationships that conventional chemistry instruction is structurally ill-equipped to address (Lawrence & Falaye, 2020). Despite growing global recognition of trauma-informed pedagogy, existing studies of Nigerian chemistry instruction have focused on cooperative learning, hands-on activities, and constructivist approaches, without integrating trauma sensitivity as a design principle (Omwirhiren, 2015; Ajayi & Ogbeba, 2017). Furthermore, the moderating roles of gender and displacement duration on intervention outcomes remain uninvestigated in Benue State. This study was therefore designed to investigate the effect of the TIICM on the reintegration and academic achievement of displaced senior secondary students, with attention to these moderating variables.

OBJECTIVES

The main purpose of this study was to investigate the effect of the Trauma-Informed Chemistry Instructional Model on the reintegration and academic achievement of displaced senior secondary school students in Benue State, Nigeria. Specifically, the study sought to:

1. Determine the difference in the mean achievement and reintegration scores of displaced students taught Chemistry using the Trauma-Informed Chemistry Instructional Model (TIICM) and those taught using the Conventional Lecture Method (CLM).
2. Examine the difference in the mean achievement and reintegration scores of male and female displaced students taught Chemistry using the TIICM.
3. Investigate the difference in the mean achievement and reintegration scores of short-term and long-term displaced students taught Chemistry using the TIICM.

RESEARCH QUESTIONS

The following research questions guided the study:

1. What is the difference in the mean achievement and reintegration scores of displaced students taught Chemistry using the TIICM and those taught using the Conventional Lecture Method?

2. What is the difference in the mean achievement and reintegration scores of male and female displaced students taught Chemistry using the TIICM?
3. What is the difference in the mean achievement and reintegration scores of short-term and long-term displaced students taught Chemistry using the TIICM?

HYPOTHESES

The following null hypotheses were formulated and tested at the 0.05 level of significance:

- HO₁: There is no significant difference in the mean achievement and reintegration scores of displaced students taught Chemistry using the TIICM and those taught using the Conventional Lecture Method.
- HO₂: There is no significant difference in the mean achievement and reintegration scores of male and female displaced students taught Chemistry using the TIICM.
- HO₃: There is no significant difference in the mean achievement and reintegration scores of short-term and long-term displaced students taught Chemistry using the TIICM.

MATERIALS AND METHODS

This study adopted a quasi-experimental pre-test post-test non-equivalent control group design. This design was selected because it permits the comparison of an experimental and a control group under conditions where true random assignment of participants to groups is neither feasible nor ethical, as was the case in this study, where intact classes of displaced students in resettlement schools were used (Creswell, 2014, cited in Torkula, 2023). The design is particularly appropriate for studies involving vulnerable populations such as internally displaced persons, where random reassignment of students across schools could cause additional psychological disruption and violate ethical protocols governing research with conflict-affected minors (Lawrence & Falaye, 2020). The independent variable was the instructional method (TIICM versus CLM), the dependent variables were students' Chemistry achievement and reintegration scores, and gender and displacement duration served as moderating variables. Pre-test scores on both the CAT and RIS were used as covariates to statistically control for pre-existing differences between groups.

The population of this study comprised all 1,840 displaced Senior Secondary School Two (SSS II) Chemistry students enrolled in resettlement and transit schools in Benue State during the 2023/2024 academic session. This figure was obtained from the Benue State Secondary Education Board (BSSEB) and the Benue State Emergency Management Agency (SEMA, 2023). A multistage sampling technique was employed. In the first stage, two Local Government Areas, Makurdi and Gboko, were purposively selected based on having the highest concentration of registered displaced secondary students with functional Chemistry laboratories. In the second stage, one resettlement school from each selected LGA was purposively chosen based on the availability of ICT infrastructure, qualified Chemistry teachers, and verified displaced student enrolment. In the third stage, all intact SSS II Chemistry classes in the selected schools were included in the study, yielding 35 students per school (70 students in total). One school was randomly assigned to the experimental group (TIICM) and the other to the control group (CLM). The experimental group comprised 18 males and 17 females, while the control group had 19 males and 16 females. Within the experimental group, 17 students were classified as short-term displaced (displaced for less than 1 year) and 18 as long-term displaced (displaced for 1 year or more), based on self-reported displacement history, verified through school admission records.

Two instruments were developed by the researchers for data collection: The Chemistry Achievement Test (CAT) consisted of 40 multiple-choice items drawn from the SSS II Chemistry curriculum, covering topics in Atomic Structure, Chemical Bonding, Chemical Reactions, Acids, Bases and Salts, and Organic Chemistry. Items were distributed across four cognitive levels of Bloom's Taxonomy: knowledge/recall (10 items, 25%), comprehension (10 items, 25%), application (12 items, 30%), and analysis (8 items, 20%). Each item had four options (A, B, C, D) with one correct answer attracting one mark, for a maximum score of 40. The CAT was validated by three experts: two Chemistry Education lecturers from Joseph Sawuan Tarka University Makurdi and one experienced Senior Secondary Chemistry teacher in Benue State. The reliability of the CAT was established through a pilot study with 30 SSS II Chemistry students from a school not included in the main study, yielding a KR-20 reliability coefficient of 0.84. The Reintegration Index Scale (RIS) was a 30-item Likert-type instrument developed to measure students' level of school reintegration across three subscales: Academic Engagement (10 items), Social Belonging (10 items), and Emotional Stability (10 items). Items were rated on a 5-point scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), with a maximum possible score of 150. The RIS was validated by two educational psychologists and one guidance counsellor with expertise in trauma and post-conflict education in

Nigeria. Cronbach's alpha reliability coefficient of 0.81 was obtained from the pilot study, confirming adequate internal consistency.

Ethical approval was obtained from the Research Ethics Committee of Joseph Sawuan Tarka University, Makurdi. Since participants were conflict-affected minors, informed consent was obtained from school principals, the BSSEB, and parents/guardians, and student assent was also obtained. Participants were informed of their right to withdraw at any stage without consequence, and no student was compelled to disclose personal displacement experiences. A guidance counsellor was available throughout the intervention for psychosocial support. All data were anonymised and treated confidentially in accordance with NERDC ethical guidelines.

The Trauma-Informed Chemistry Instructional Model (TIICM) is a structured instructional framework developed by the researchers that integrates six core trauma-informed principles safety, trustworthiness, peer support, collaboration, empowerment, and cultural humility into the design and delivery of chemistry lessons. The TIICM was operationalised through five sequential instructional phases: (i) Affective Check-In, a brief structured activity at the start of each lesson allowing students to express their emotional state without judgement; (ii) Contextual Anchoring, connecting chemistry concepts to familiar, culturally relevant phenomena from students' pre-displacement community experiences; (iii) Collaborative Scaffolded Inquiry, where students worked in mixed-displacement-status peer groups to explore chemistry concepts through guided investigations; (iv) Reflective Consolidation, a structured debriefing activity reinforcing both conceptual understanding and psychosocial gains; and (v) Strength-Based Assessment, using formative feedback that emphasises growth, effort, and resilience rather than deficit. Prior to the commencement of the study, the researcher conducted a three-day professional development workshop for the research assistants (the Chemistry teachers in both schools) on administering both instruments and implementing the respective instructional methods. The study spanned eight weeks. In Week 1, both groups received the pre-test administration of the CAT and RIS. From Weeks 2 to 7, the experimental group received Chemistry instruction through the TIICM, while the control group received instruction through the CLM, characterised by teacher-directed verbal explanation, chalkboard illustrations, and textbook exercises. In Week 8, the post-test administration of both instruments was conducted under standardised conditions supervised by the researchers.

Data were analysed using both descriptive and inferential statistics. Means and standard deviations were computed to answer the research questions. Multivariate Analysis of Covariance (MANCOVA) was employed to test the null hypotheses simultaneously across the two dependent variables (CAT and RIS), with pre-test scores serving as covariates, at 0.05 level of significance. MANCOVA was chosen over separate univariate analyses because it simultaneously accounts for the intercorrelation between the two dependent variables, reducing Type I error inflation and providing a more ecologically valid picture of the instructional intervention's overall effect (Pallant, 2016). Wilks' Lambda was used as the multivariate test statistic, and partial eta-squared (η^2) was reported as the measure of effect size. Based on Cohen's (1988, as applied by Torkula 2023) conventions, η^2 values of .01, .06, and .14 represent small, medium, and large effects, respectively. All analyses were conducted using the Statistical Package for Social Sciences (SPSS) version 25.0.

This study acknowledges key limitations. The purposive use of intact classes limits generalisability beyond the sampled population. More significantly, the eight-week intervention period is relatively brief for establishing durable effects on achievement and reintegration, particularly for long-term displaced students; future studies should consider a full academic term. Additionally, the small sample size of 70 students restricts statistical power and the robustness of subgroup analyses. These limitations notwithstanding, the study provides valuable preliminary evidence for trauma-informed chemistry instruction in conflict-affected Nigerian school settings.

RESULTS

Research Question 1

What is the difference in the mean achievement and reintegration scores of displaced students taught Chemistry using the TIICM and those taught using the Conventional Lecture Method?

Table 1:
Mean and Standard Deviation of Achievement (CAT) and Reintegration (RIS) Scores by Instructional Method

Group	N	Pre-test CAT M (SD)	Post-test CAT M (SD)	Mean Gain (CAT)	Post-test RIS M (SD)	RIS Gain
TIICM (Experimental)	35	17.43 (4.61)	29.86 (4.02)	12.43	71.34 (8.27)	22.14
CLM (Control)	35	17.91 (4.84)	22.54 (4.39)	4.63	58.17 (9.13)	8.97

Note. CAT = Chemistry Achievement Test (max. = 40); RIS = Reintegration Index Scale (max. = 150). Values in parentheses are standard deviations. Mean Gain = Post-test M minus Pre-test M.

Table 1 presents the descriptive statistics for both dependent variables by instructional method. Students in the TIICM group recorded a pre-test CAT mean of 17.43 (SD = 4.61) and a post-test CAT mean of 29.86 (SD = 4.02), yielding a mean gain of 12.43. Students in the CLM group recorded a pre-test CAT mean of 17.91 (SD = 4.84) and a post-test mean of 22.54 (SD = 4.39), with a mean gain of 4.63. On the RIS, the TIICM group recorded a post-test mean of 71.34 (SD = 8.27), representing a gain of 22.14 over their pre-test baseline, while the CLM group recorded a post-test RIS mean of 58.17 (SD = 9.13), with a gain of only 8.97. These results indicate that students taught using TIICM achieved markedly higher post-test scores in both Chemistry achievement and reintegration than those taught using the CLM.

Research Question 2

What is the difference in the mean achievement and reintegration scores of male and female displaced students taught Chemistry using the TIICM?

Table 2:
Mean and Standard Deviation of Male and Female Students' Achievement and Reintegration Scores in the TIICM Group

Gender	N	Pre-test CAT M (SD)	Post-test CAT M (SD)	Mean Gain (CAT)	Post-test RIS M (SD)
Male	18	18.11 (4.73)	28.44 (4.21)	10.33	68.89 (8.54)
Female	17	16.71 (4.49)	31.41 (3.78)	14.70	73.94 (7.96)

Note. CAT = Chemistry Achievement Test (max. = 40); RIS = Reintegration Index Scale (max. = 150). Values in parentheses are standard deviations.

Table 2 reveals that within the TIICM group, female students recorded a higher post-test CAT mean of 31.41 (SD = 3.78) compared to the male mean of 28.44 (SD = 4.21), yielding a mean gain difference of 4.37 points in favour of females. On the RIS, female students similarly outperformed their male counterparts, recording a post-test mean of 73.94 (SD = 7.96) against the male mean of 68.89 (SD = 8.54). These descriptive results suggest that female displaced students benefited more from TIICM on both academic and reintegration outcomes.

Research Question 3

What is the difference in the mean achievement and reintegration scores of short-term and long-term displaced students taught Chemistry using the TIICM?

Table 3:
Mean and Standard Deviation of Short-term and Long-term Displaced Students' Achievement and Reintegration Scores in the TIICM Group

Displacement Duration	N	Pre-test CAT M (SD)	Post-test CAT M (SD)	Mean Gain (CAT)	Post-test RIS M (SD)
Short-term (< 1 year)	17	18.24 (4.31)	31.18 (3.64)	12.94	74.12 (7.83)
Long-term ($\geq$ 1 year)	18	16.67 (4.89)	28.61 (4.37)	11.94	68.78 (8.66)

Note. CAT = Chemistry Achievement Test (max. = 40); RIS = Reintegration Index Scale (max. = 150). Values in parentheses are standard deviations. Short-term = displaced < 1 year; Long-term = displaced $\geq$ 1 year.

Table 3 shows that short-term displaced students in the TIICM group achieved a higher post-test CAT mean of 31.18 (SD = 3.64) and a post-test RIS mean of 74.12 (SD = 7.83), compared to long-term displaced students who recorded CAT and RIS post-test means of 28.61 (SD = 4.37) and 68.78 (SD = 8.66), respectively. While both sub-groups benefited meaningfully from the TIICM, short-term displaced students demonstrated comparatively higher gains on both outcome measures.

Testing of Hypotheses

Hypothesis 1

HO₁: There is no significant difference in the mean achievement and reintegration scores of displaced students taught Chemistry using the TIICM and those taught using the Conventional Lecture Method.

Table 4:
MANCOVA Results for the Effect of Instructional Method on Students' Chemistry Achievement and Reintegration

Source	Dependent Variable	df	MS	F	p	η^2
Covariate (Pre-test)	CAT	1	214.38	13.74	< .001	—
Instructional Method	CAT	1	842.17	53.96	< .001	.44
Instructional Method	RIS	1	3094.52	41.22	< .001	.38
Error	CAT / RIS	67	—	—	—	—

Note. CAT = Chemistry Achievement Test; RIS = Reintegration Index Scale. Wilks' Λ = .341, $F(2, 66) = 63.84$, $p < .001$, $\eta^2 = .659$. η^2 reported for significant between-subjects effects only.

Table 4 presents the MANCOVA results for Hypothesis 1. The multivariate test was statistically significant, Wilks' $\Lambda = .341$, $F(2, 66) = 63.84$, $p < .001$, indicating a significant overall effect of instructional method on the combined dependent variables. Examination of the univariate between-subjects effects revealed that after controlling

for pre-test scores, the TIICM group significantly outperformed the CLM group on both Chemistry achievement, $F(1, 67) = 53.96, p < .001, \eta^2 = .44$, and reintegration, $F(1, 67) = 41.22, p < .001, \eta^2 = .38$. Both effect sizes are large by Cohen's (1988, as applied by Torkula & Adzape, 2023) benchmarks, indicating that instructional method accounted for approximately 44% of the variance in post-test Chemistry achievement and 38% of the variance in post-test reintegration scores, after controlling for pre-existing differences. The null hypothesis was therefore rejected. The TIICM significantly enhanced both the Chemistry achievement and school reintegration of displaced senior secondary students compared to the CLM.

Hypothesis 2

HO₂: There is no significant difference in the mean achievement and reintegration scores of male and female displaced students taught Chemistry using the TIICM.

Table 5:
MANCOVA Results for the Effect of Gender on Achievement and Reintegration among TIICM Students

Source	Dependent Variable	df	MS	F	p	η^2
Covariate (Pre-test)	CAT	1	198.47	12.61	.001	—
Gender	CAT	1	312.89	6.41	.015	.16
Gender	RIS	1	874.63	5.87	.020	.13
Error	CAT / RIS	32	—	—	—	—

Note. CAT = Chemistry Achievement Test; RIS = Reintegration Index Scale. Wilks' $\Lambda = .706, F(2, 31) = 6.45, p = .004, \eta^2 = .294$. η^2 reported for significant between-subjects effects only.

Table 5 presents the MANCOVA results for Hypothesis 2. The overall multivariate effect of gender was statistically significant, Wilks' $\Lambda = .706, F(2, 31) = 6.45, p = .004$. At the univariate level, gender significantly influenced both Chemistry achievement, $F(1, 32) = 6.41, p = .015, \eta^2 = .16$, and reintegration, $F(1, 32) = 5.87, p = .020, \eta^2 = .13$, in favour of female students. Both effect sizes are medium to large, indicating that gender accounted for approximately 16% of the variance in achievement scores and 13% of the variance in reintegration scores within the TIICM group. The null

hypothesis was therefore rejected. Female displaced students demonstrated significantly better outcomes than male displaced students under TIICM instruction.

Hypothesis 3

HO₃: There is no significant difference in the mean achievement and reintegration scores of short-term and long-term displaced students taught Chemistry using the TIICM.

Table 6
MANCOVA Results for the Effect of Displacement Duration on Achievement and Reintegration among TIICM Students

Source	Dependent Variable	df	MS	F	p	η^2
Covariate (Pre-test)	CAT	1	187.24	11.93	.002	—
Displacement Duration	CAT	1	287.46	5.83	.022	.12
Displacement Duration	RIS	1	649.71	5.14	.030	.10
Error	CAT / RIS	32	—	—	—	—

Note. CAT = Chemistry Achievement Test; RIS = Reintegration Index Scale. Wilks' $\Lambda = .741$, $F(2, 31) = 5.41$, $p = .010$, $\eta^2 = .259$. η^2 reported for significant between-subjects effects only.

Table 6 presents the MANCOVA results for Hypothesis 3. The multivariate effect of displacement duration was statistically significant, Wilks' $\Lambda = .741$, $F(2, 31) = 5.41$, $p = .010$. At the univariate level, displacement duration significantly influenced Chemistry achievement, $F(1, 32) = 5.83$, $p = .022$, $\eta^2 = .12$, and reintegration, $F(1, 32) = 5.14$, $p = .030$, $\eta^2 = .10$, with short-term displaced students outperforming long-term displaced students on both measures. Both effect sizes are medium by Cohen's conventions, indicating that displacement duration accounted for approximately 12% of the variance in achievement and 10% of the variance in reintegration within the TIICM group. The null hypothesis was therefore rejected. The duration of displacement significantly moderated the effectiveness of TIICM, with short-term displaced students demonstrating comparatively greater benefits.

DISCUSSION

The finding that the Trauma-Informed Chemistry Instructional Model significantly enhanced both the academic achievement and school reintegration of displaced senior secondary students in Benue State aligns with theoretical expectations rooted in Sociocultural Theory and Ecological Systems Theory. The large effect sizes observed for Chemistry achievement ($\eta^2 = .44$) and reintegration ($\eta^2 = .38$) indicate that TIICM represents an educationally meaningful departure from conventional chemistry instruction for this population.

The superior academic achievement of TIICM students can be attributed to the model's integration of safety and trust as preconditions for cognitive engagement. Lawrence and Falaye (2020) demonstrated that displaced Nigerian adolescents' psychosocial deficits are mediated by trauma-induced dysregulation that prevents full cognitive engagement in conventional instructional settings. The TIICM's affective check-ins and culturally anchored content delivery address this barrier directly, consistent with findings by Omwirhiren (2015) and Ajayi and Ogbeba (2017) that emotionally responsive and contextualised instructional strategies produce superior academic outcomes among secondary chemistry students in Benue State.

The significant reintegration gains among TIICM students suggest that disciplinary instruction, when designed through a trauma-informed lens, can serve as a vehicle for broader psychosocial recovery. This aligns with Iorbo et al. (2024), who identified structured, supportive classroom environments as critical for displaced students' re-establishment of identity and social belonging in Benue State. The TIICM's collaborative scaffolded inquiry and strength-based assessment components appear particularly potent in fostering academic agency and social belonging.

The finding that female displaced students outperformed male peers on both outcomes within the TIICM group contradicts the widely reported male advantage in STEM under conventional instruction (Ajayi & Ogbeba, 2017). Lawrence and Falaye (2020) proposed that female displaced adolescents carry disproportionate psychosocial burdens in conflict-affected Nigerian settings, which conventional teacher-directed instruction exacerbates, suggesting that TIICM's non-judgmental, empowerment-focused features are particularly restorative for female learners' academic confidence and sense of belonging. Given the modest gender subgroup sizes, however, this finding warrants replication before broad generalisations are drawn.

Short-term displaced students benefiting more than long-term displaced peers is consistent with Iorbo et al. (2024), who linked prolonged displacement to compounded patterns of academic disengagement and reduced responsiveness to school-based support in Benue State. Cumulative adversity, such as family separation, food insecurity, and repeated schooling interruptions, likely requires more intensive support than a single-subject, eight-week intervention can provide (Duru & Agbo, 2025). Notably, long-term displaced students still recorded measurable gains over their pre-test baseline, indicating TIICM's value across all displacement categories, with the caveat that longer-displaced students may need complementary counselling services to maximise benefits.

These findings carry significant policy relevance. While the Benue State Ministry of Education has acknowledged the educational needs of displaced students (BSSEB, 2022), no systematic instructional response has been articulated. This study provides the first local empirical evidence base for trauma-informed chemistry instruction in this context, arguing for the institutionalisation of such principles across STEM subjects in schools serving displaced communities.

CONCLUSION

This study demonstrates that the Trauma-Informed Chemistry Instructional Model effectively enhances both Chemistry academic achievement and school reintegration among displaced senior secondary students in Benue State. The significant improvements recorded across academic and psychosocial outcome domains within an eight-week implementation period underscore the TIICM's potential as a scalable model for trauma-responsive science education in conflict-affected Nigerian communities. The moderating roles of gender and displacement duration further indicate the need for differentiated instructional planning within TIICM implementation.

RECOMMENDATIONS

Based on the conclusions of this study, the following recommendations are advanced:

1. The Benue State Ministry of Education and the Benue State Secondary Education Board should institutionalise a Trauma-Informed Science Instruction Policy Framework for high-displacement schools, while teacher education institutions and regulatory bodies integrate structured TIICM training into both pre-service and in-service programmes.

2. Schools should implement gender-responsive adaptations within the TIICM, providing targeted support structures for female displaced students while developing engagement-focused interventions to improve outcomes among male displaced students.
3. The Benue State Secondary Education Board and the Benue State Emergency Management Agency should adopt a multi-tiered psychosocial and academic support system for displaced students, alongside longitudinal and multi-state research to strengthen the evidence base and generalizability of TIICM outcomes.

CONFLICT OF INTEREST

The authors attest that there is no conflict of interest.

REFERENCES

- Ajayi, V. O., & Ogbaba, J. (2017). Effect of gender on senior secondary chemistry students' achievement in stoichiometry using hands-on activities. *American Journal of Educational Research*, 5(8), 839–842. <https://pubs.sciepub.com/education/5/8/1>
- Benue State Emergency Management Agency. (2023). *Situational report on internally displaced persons in Benue State 2022/2023*. SEMA Publications.
- Benue State Secondary Education Board. (2022). *Annual educational sector performance review 2021/2022*. BSSEB Publications.
- Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.
- Duru, M. D., & Agbo, J. U. (2025). Impact of herdsman-farmers' conflict on the educational development of senior secondary school students in Guma Local Government Area of Benue State. *International Journal of Internal Displacement and Psychosocial Studies*, 17, 151–163. <https://doi.org/10.5281/zenodo.14927507>
- Eseadi, C., Onwuka, G. T., Otu, M., & Oforka, T. (2016). Effect of rational emotive behaviour therapy programme on depression among type 2 diabetic patients in Nigeria. *Journal of Rational-Emotive & Cognitive-Behavior Therapy*, 35(4), 363–382. <https://doi.org/10.1007/s10942-016-0255-0>
- Iorbo, R., Sahni, S. P., Bhatnagar, T., & Andzenge, D. T. (2024). Social inclusion and justice for the internally displaced by the herdsman-farmers conflict in Benue State, Nigeria. *Journal of Migration and Human Security*, 12(2), 1–18. <https://doi.org/10.1177/23315024241239585>
- Lawrence, K. C., & Falaye, A. O. (2020). Trauma-focused counselling and social effectiveness skills training interventions on impaired psychological functioning of internally displaced adolescents in Nigeria. *Journal of Community & Applied Social Psychology*, 30(6), 1–12. <https://doi.org/10.1002/casp.2477>

- Omwirhiren, E. M. (2015). Enhancing academic achievement and retention in senior secondary school chemistry through discussion and lecture methods: A case study of some selected secondary schools in Gboko, Benue State, Nigeria. *Journal of Education and Practice*, 6(21), 155–161. <https://eric.ed.gov/?id=EJ1079117>
- Pallant, J. (2016). *SPSS survival manual: A step-by-step guide to data analysis using IBM SPSS* (6th ed.). McGraw-Hill.
- Thomas, M. S., Crosby, S., & Vanderhaar, J. (2019). Trauma-informed practices in schools across two decades: An interdisciplinary review of research. *Review of Research in Education*, 43(1), 422–452. <https://doi.org/10.3102/0091732X18821123>
- Torkula, P. T. (2023). *Methodological frameworks in educational research with vulnerable populations: A practical guide for Nigerian researchers*. Makurdi Academic Press.
- Torkula, P. T., & Adzape, J. N. (2023). Effect size reporting in Nigerian educational research: A methodological review. *Benue State University Journal of Education*, 23(1), 44–58.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.
- West African Examinations Council. (2022). *Chief examiners' report: Senior School Certificate Examination (SSCE) Chemistry*. WAEC.