

The Extent of Prediction of Visual and Kinesthetic Learning Styles in Academic Achievement among Junior School Learners in Igembe South Sub-County, Meru County, Kenya

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DOI: <https://doi.org/10.47772/IJRISS.2026.100800953>

Received: 06 September 2026; Accepted: 11 September 2026; Published: 21 September 2026

ABSTRACT

Integrated Science is a core learning area in Kenya's Competency-Based Education (CBE) that aims to develop learners' scientific inquiry, reasoning and problem-solving skills. However, persistent concerns have been raised over low academic achievement in this learning area among junior school learners in Igembe South Sub-County, Meru County, Kenya. This study examined the extent to which visual and kinesthetic learning styles predict academic achievement in Integrated Science among junior school learners in this Sub-County. The study employed Kolb's Experiential Learning Theory (1984) and adopted a correlational predictive research design. The target population comprised all junior school learners (9,253) and teachers (249) across 51 schools in the Sub-County, from which a sample of 368 respondents (358 learners, 10 teachers) was drawn through purposive, proportionate and random sampling. Reliability, determined using Cronbach's alpha, yielded a coefficient of 0.74. Data were collected using structured and semi-structured questionnaires, achieving a 98.9% response rate, and analyzed using SPSS version 30 and thematic analysis, with inferential statistics including multiple regression at the 0.05 significance level. The overall regression model was statistically significant, $F(2,351) = 4.428$, $p = .013$, with visual and kinesthetic learning styles jointly accounting for 2.5% ($R^2 = .025$) of the variance in academic achievement. Kinesthetic learning style was the only individually significant predictor ($\beta = .145$, $p = .017$), while visual learning style was positive but insignificant ($\beta = .109$, $p = .073$). The study concluded that both styles jointly but modestly predict academic achievement, with kinesthetic engagement carrying the stronger contribution and the low explained variance attributable partly to unmeasured factors such as socio-economic status and resource availability, and recommends that teachers combine visual scaffolds with structured practical activities, that administrators equip laboratories with basic apparatus and visual aids, and that curriculum and policy bodies strengthen investigation-based learning and incorporate practical assessment.

Keywords: Visual, Kinesthetic, Academic Achievement, Integrated Science, Predictors

INTRODUCTION

Background Information

Learning styles play a crucial role in shaping how learners understand, process and apply scientific concepts. In junior school, learning areas such as Integrated Science require teaching approaches that support learners' diverse preference in order to improve comprehension and achievement (Mayer, 2021). Among the various learning styles, visual and kinesthetic learning styles are of more importance in Integrated Science (Novinovrita & Setiawan, 2024). Visual learning style involves understanding information through observation and imagery; according to Arni, et al. (2024) learners who learn best through visual methods tend to understand concepts more effectively when teachers use materials like diagrams, charts and pictures. In Integrated Science, complex topics such as photosynthesis, energy transfer and atomic structure are easier to grasp when lessons include visual demonstrations (Arni et al., 2024). On the other hand, kinesthetic learners benefit most from activities that involve physical engagement and hands-on experience (Team GIIS, 2021). Instead of merely taking in knowledge passively, these learners engage more actively when instruction includes movement, material manipulation, experimentation or demonstration (Ojonugwa, 2023). For example, a kinesthetic learner would

learn better from making an atom model or performing an energy transfer test. By involving visual and kinesthetic learning styles, learners can readily generate information, draw connections between theory and practice and build critical knowledge for lifetime learning (Uwizeyimana et al., 2021).

Academic achievement, which is mostly used as a measure of learning attainment, is the degree to which learners fulfill predicted educational goals within a given time frame (Hailu et al., 2024). It stands for the curriculum-described acquisition of skills, information and attitudes. According to studies, a thorough assessment of learners' academic achievement can be obtained by combining exam results with ongoing evaluation (Hailu et al., 2024). Academic achievement is predicted by a number of related factors operating at the learner, teacher, school and home levels. It is more predicted by learner-related factors, for example motivation, learning technique, preferred learning styles and prior knowledge (Suleiman et al., 2024). It has also been shown that factors linked to educators and educational institutions, such as instructional approach, teacher expertise, resource availability and the general learning environment, are highly predictive of learners' academic achievement (Suhaini et al., 2020). As part of larger educational reforms targeting the boosting of practical skills and encouraging learner-centered instruction, education sectors in many countries have adopted visual and kinesthetic learning styles that help learners comprehend scientific concepts. As a result, many countries have revised their curricula to integrate strategies that reinforce learning styles and provide learners with interactive visual and hands-on learning experience, a focus that enhances critical thinking, creative thinking and practical application of theories (Torrance, 2020). Because it enhances observation, research and hands-on experience as vital routes to mastery, Competency Based Education suits very well with visual and kinesthetic learning styles.

Statement of the Problem

The development of problem-solving and practical skills depends on Integrated Science. Nonetheless, a large number of Kenyan junior school learners still perform appallingly in the subject area. Particularly in Igembe South Sub-County, learners frequently find it difficult to comprehend and apply scientific concepts, due in part to junior school learners' continued exposure to teacher-centered approaches in the teaching and learning of Integrated Science, which results in low academic achievement in the learning area. As a result, there is a need to establish the extent to which visual and kinesthetic learning styles predict academic achievement in Integrated Science among junior school learners in Igembe South Sub-County, Meru County, Kenya.

LITERATURE REVIEW

Understanding the prevalence of visual and kinesthetic learning preferences among junior school learners is essential for developing effective teaching strategies in Integrated Science, since learners differ in how they perceive, process and retain information. Hadiprayitno (2020) found that Islamic junior school learners in Mataram, Indonesia, showed a strong preference for visual and kinesthetic learning modalities, with such learners recording higher levels of scientific literacy and engagement. Similarly, Agu (2021), investigating preclinical medical trainees at the University of Nigeria using a quantitative survey design and the VARK questionnaire, found visual and kinesthetic styles to be widely prevalent among learners.

On the relationship between visual learning and achievement, Xiong (2025) examined how learner-centered instruction and visual aids affected Chinese secondary school learners' academic achievement and motivation, finding that visual presentation improved motivation, engagement and achievement. El-Saftawy (2024), investigating the VARK model's effect on laboratory science performance in Egypt, and Dirungu (2024), evaluating the impact of matching instructional strategies to junior learners' visual preferences in Kenya, both reported that learners performed and engaged better when instruction matched their visual learning needs.

On kinesthetic learning, Stamm (2021) notes that learners who engage physically with content demonstrate deeper understanding, a finding echoed by Mosley (2025), who found that interactive learning activities improved comprehension among elementary learners. In the African context, Dagne (2025) used a mixed methods design with 350 secondary Ethiopian learners and found that kinesthetic approaches improved engagement and conceptual understanding, while Chikendu and Chukwunazo (2022), studying 478 senior

secondary learners in Nigeria's Enugu State, confirmed that kinesthetic learners outperformed their peers and that practical exposure predicted higher achievement.

On the joint predictive role of both styles, Ahmad et al. (2023), using multiple regression with 500 Malaysian secondary school learners, found that visual and kinesthetic learning styles significantly predicted learners' academic behaviours, each with distinct contributions. Wan Hussin (2023) reported that visual learners had higher attention scores while kinesthetic learners showed higher cooperation and motivation, both contributing to achievement. In Kenya, Kebaso (2023), using a correlational approach under the VARK framework with Form Three learners in Nakuru County, found that both visual ($r = .74$) and kinesthetic ($r = .76$) learning styles significantly predicted chemistry achievement, with kinesthetic emerging as the slightly stronger predictor.

THEORETICAL FRAMEWORK

This study is guided by Kolb's Experiential Learning Theory (1984), which explains learning as a continuous and dynamic process in which learners construct knowledge from experience through four phases: concrete experience, reflective observation, abstract conceptualization and active experimentation (Johnson et al., 2020). The theory explains how visual and kinesthetic learning styles fit into this cycle: the stages of reflective observation and abstract conceptualization, where learning is aided by diagrams, drawings, models and visual demonstrations of scientific processes, correspond to visual learning, while concrete experience and active experimentation, where learners physically manipulate materials and test ideas, correspond to kinesthetic learning. The theory frames these visual and kinesthetic phases as integrated rather than separate components of a single learning cycle, which underpins this study's expectation that the two styles would jointly, rather than independently, predict academic achievement.

1.4 Objective of the Study

To establish the extent of prediction of visual and kinesthetic learning styles in academic achievement among junior school learners in Igembe South Sub-County, Meru County, Kenya.

1.5 Hypothesis

H₀: There is no statistically significant predictive relationship between visual and kinesthetic learning styles and academic achievement among junior school learners in Igembe South Sub-County, Meru County, Kenya.

METHODOLOGY

The study employed a correlational predictive research design to examine the predicted relationship between learners' academic achievement and learning styles without altering variables. The target population for this study was derived from all 51 public junior schools in Igembe South Sub-County, Meru County, Kenya, targeting all 249 teachers and 9,253 learners. The sample size for this study translated to 368 respondents, comprising 10 teachers and 358 learners drawn from 10 purposively selected schools. The study used a different structured questionnaire for learners and Integrated Science teachers to collect data.

Validity in this study ensured that the tools appropriately recorded data on kinesthetic and visual learning styles and how they predicted academic achievement in Integrated Science. The instrument underwent face and content validation, with experts in education and Integrated Science, including experienced educators and university lecturers, consulted to guarantee content validity. Construct validity of the combined ten-item visual and kinesthetic learning style scale was further assessed through the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, which yielded a value of 0.621, exceeding the minimum recommended value of .60 (Kothari, 2005) and confirming that the sample and inter-item correlations were adequate for meaningful aggregation into composite scores.

Reliability was assessed using Cronbach's Alpha coefficient to determine internal consistency, with a reliability index of 0.7 or higher considered acceptable for the learner and teacher questionnaires. The combined ten-item learning style scale yielded a Cronbach's alpha of 0.74, indicating acceptable internal consistency and confirming

that the items sufficiently measured their underlying constructs to justify their aggregation into the composite Visual Learning (VL) and Kinesthetic Learning (KL) scores used in the analysis.

Of the 358 questionnaires distributed to learners, 354 were usable for analysis after four were excluded due to incomplete responses, giving a 98.9% learner response rate; all 10 teacher questionnaires were fully completed, giving a 100% teacher response rate. The overall response rate of 98.9% exceeded the 70% threshold recommended by Mugenda and Mugenda (2003), substantially reducing the risk of non-response bias and strengthening the external validity of the inferential analyses that followed.

RESULTS

3.1 Demographic Characteristics of Respondents

It was found that learners aged 14–15 years formed the majority ($n = 173$, 48.87%), followed closely by those aged 12–13 years ($n = 168$, 47.46%), with a small proportion aged 16 years and above ($n = 13$, 3.67%). Female learners made up 65.82% ($n = 233$) of the sample compared to 34.18% ($n = 121$) male, a gender composition that reflects school-level enrolment patterns in Igembe South Sub-County. Among Integrated Science teachers, 90% were aged 21–30 years, 90% were male and 90% had 1–10 years of teaching experience. Respondents indicated their agreement with statements on learning styles using a Likert scale with values Never (1), Rarely (2), Sometimes (3), Often (4) and Always (5).

3.2 Description of Learning Styles and Academic Achievement

Having presented the bivariate relationship of each learning style with academic achievement, this section presents a side-by-side description of the two predictor variables (Visual Learning Score and Kinesthetic Learning Score) and the dependent variable (academic achievement) prior to the joint hypothesis test. Table 1 presents the consolidated descriptive statistics for the three variables.

Table 1: Descriptive Statistics for Visual Learning, Kinesthetic Learning and Academic Achievement

Variable	Range	M	SD	Skewness (SE)
End-Term Score (Academic Achievement)	95	52.05	17.10	−0.03 (.13)
VL Score (Visual Learning)	2.80	3.79	0.53	−0.16 (.13)
KL Score (Kinesthetic Learning)	3.00	3.68	0.58	−0.56 (.13)

As shown in Table 1, the composite Visual Learning Score ($M = 3.79$, $SD = 0.53$) and the composite Kinesthetic Learning Score ($M = 3.68$, $SD = 0.58$) both situated learners towards the upper end of the five-point Likert continuum, indicating that learners in Igembe South Sub-County endorse both modalities at broadly comparable levels, with a slight numerical edge for visual learning. The standard deviations of the two composite scores are narrow relative to the theoretical 1–5 range, indicating range restriction in the predictor variables, a feature with implications for the size of the explained variance in the regression model reported in Section 3.3. Academic achievement ($M = 52.05$, $SD = 17.10$) recorded a wide spread of scores (range = 95) and a near-symmetric distribution (skewness = -0.03 , kurtosis = 0.36), confirming its suitability as the dependent variable in a multiple linear regression.

Examination of multicollinearity diagnostics from the subsequent regression model (Tolerance = .893, VIF = 1.12) indicates that the two predictors share a moderate positive linear association (approximate inter-predictor $r \approx .33$), well below the threshold that would compromise the multivariate analysis. This shared variance is theoretically expected in this context, as practical lessons commonly engage both visual processing (apparatus, instrument scales) and kinesthetic action (manipulation, model-making) simultaneously.

Hypothesis Testing

Having established the single predictive relationship of visual and kinesthetic learning on academic achievement, a multivariate regression analysis was conducted to establish the combined effects of the two variables. A multiple linear regression was conducted with end-term academic achievement as the dependent variable and VL Score and KL Score as predictors. The results, summarized in Table 2, showed that the overall regression model was statistically significant, $F(2, 351) = 4.428$, $p = .013$, with the combined visual and kinesthetic learning style predictors accounting for only 2.5% ($R^2 = .025$) of the variance in academic achievement. This reflects that the great majority of achievement variance remains attributable to factors outside the model.

Table 2: ANOVA Summary for Multiple Linear Regression

Source	SS	df	MS	F	p
Regression	2,539.27	2	1,269.63	4.428	.013
Residual	100,694.57	351	286.88		
Total	103,233.84	353			

Table 3: Individual Predictor Contributions to Academic Achievement

Predictor	B	β	t	p	Tolerance	VIF
(Constant)	30.08		3.98	< .001		
VL Score	3.24	.109	1.80	.073	.893	1.12
KL Score	3.97	.145	2.39	.017	.893	1.12

From Table 3, kinesthetic learning style was the only individually statistically significant predictor in the joint model ($\beta = .145$, $p = .017$), while visual learning style was positive but insignificant ($\beta = .109$, $p = .073$) at the 5% significance level. The statistical tolerance (.893) and VIF (1.12) confirm the absence of problematic multicollinearity. Each one-unit increase in kinesthetic style score predicts an additional 3.97 points in end-term achievement (holding visual constant), compared to 3.24 points for visual style (holding kinesthetic constant), with kinesthetic carrying both the larger unstandardized B and the larger standardized β coefficients. This implies the rejection of H_0 : there is no statistically significant predictive relationship between visual and kinesthetic learning styles and academic achievement.

Thematic Analysis of Teachers' Responses

To complement the quantitative findings, a thematic analysis of teachers' open-ended responses on the predictive role of visual and kinesthetic learning styles is presented, in line with the methodological convention of locating qualitative thematic evidence after quantitative analysis. Each teacher response was coded T1 to T10, representing all 10 teachers involved in the study. Table 4 summarizes the four dominant themes identified.

Table 4: Themes from Teachers on the Predictive Role of Learning Styles

Theme	Representative Quotation/Evidence	Frequency
Active processing of scientific content	"By predicting how effectively learners understand, retain and apply scientific knowledge" (T6); "They influence how learners process and retain information" (T10)	7/10
Enhanced comprehension and retention	"They understand the concept better, so they remember during the assessment" (T1); "They increase the speed of content mastery" (T3)	6/10
Complementary use of both styles maximises outcomes	"When both are used in learning, they help highly in improving the learners' achievement" (T5); "They are most effective when used together" (T3)	5/10
Differential advantage by assessment type	"Learners with strong visual preferences perform better in theory; kinesthetic learners perform better in practicals" (T2)	4/10

The most prevalent theme was active processing of scientific content, cited by seven out of 10 teachers, which directly supports the joint significance of the regression model and mirrors Kolb's (1984) framework in which both reflective-observational (visual) and concrete-experimental (kinesthetic) modes are constitutive of learning.

The theme of complementary use of both styles (5/10 teachers) qualitatively explains the suppression of the individual visual coefficient in the multivariate model: as T3 noted, the two styles “are most effective when used together,” meaning that their achievement contributions overlap rather than compete. The theme of differential advantage by assessment type, raised by T2 and observed in 4 out of 10 teachers, is a particularly important finding because it raises a methodological caution: the use of an end-term theoretical examination as the dependent variable in this study likely understates the kinesthetic advantage, since kinesthetic learners' competencies are often better expressed in practical assessment formats. Wan Hussin (2023), Chikendu and Chukwunazo (2022) and Edulan et al. (2022) all converge on this conclusion, implying that the kinesthetic effect detected in the present model is already the stronger individual predictor and would likely be larger still if the dependent variable included practical assessment components.

DISCUSSION

The implication of the rejection of H_0 is that visual and kinesthetic learning styles, taken together, exert a statistically significant joint prediction on academic achievement in Integrated Science among Grade 8 learners in Igembe South Sub-County, with kinesthetic learning emerging as the dominant individual contributor in the multivariate framework. The substantive interpretation is that improving learners' opportunities to engage both visually and kinesthetically, and especially kinesthetically through structured practical and experimental activities, should be expected to produce measurable gains in Integrated Science achievement. The fact that visual learning's individual coefficient was not statistically significant once kinesthetic learning was controlled for suggests that, in this instructional context, much of the achievement-relevant component of visual learning is in fact channeled through kinesthetic activities themselves. That is, practical lessons inherently involve visual processing of apparatus, instrument scales, experimental outcomes and result tables, so the unique contribution of visual learning beyond what kinesthetic engagement already captures is statistically modest. This interpretation is consistent with Kolb's (1984) Experiential Learning Theory, which describes the visual-reflective and kinesthetic-experimental phases as integrated rather than separate components of the learning cycle.

The result is directionally consistent with, as well as in some respects contradicting, the reviewed sources on the joint predictive role of these two learning styles. Ahmad et al. (2023), using multiple regression analysis with 500 Malaysian secondary school learners across five public schools, found that visual and kinesthetic learning styles significantly predicted differences in learners' learning behaviours, with both styles showing distinct contributions. Wan Hussin (2023) reported that visual learners had higher attention scores while kinesthetic learners showed higher cooperation and motivation, both contributing to achievement. Chikendu (2022) reported a significant positive correlation between kinesthetic learning style and academic achievement, with the implication that learners engaging in physical practice, experimentation and skill demonstration outperformed those who relied mostly on visual inputs. Kebaso (2023), using a correlational research approach with regression analysis under the VARK framework, found that both visual ($r = .74$) and kinesthetic ($r = .76$) learning styles significantly predicted chemistry achievement among Form Three learners in Nakuru County, Kenya, with kinesthetic emerging as the slightly stronger predictor, directionally identical to the present finding.

The most predominant causes of the difference in magnitude between these results and the substantially larger variances explained in some of the comparison studies are interconnected. First, range restriction in the predictor variables, where the standard deviations of VL Score and KL Score in this sample (0.53 and 0.58 respectively) are narrow relative to the theoretical range (1-5), mathematically attenuates the explained variance, a constraint less pronounced in studies using categorical VARK assignments (Kebaso, 2023; Agu, 2021). Second, the number of predictors used by each study has substantial effects due to variable interactions: the model deployed by this study included only two predictors, while Suleiman et al. (2024) and Suhaini et al. (2020) demonstrate in systematic reviews that academic achievement is jointly predicted by learner motivation, study methods, prior knowledge, teacher competence and resource availability, variables not included in this study whose absence inflates the residual variance and depresses the realised R^2 .

A further factor is assessment style and specificity: end-term examinations capture predominantly theoretical competence, while learning-style-aligned instruction, particularly kinesthetic engagement, also produces

benefits in practical, project and inquiry-based work that a written examination is not designed to detect. This is a material limitation of the present design, since kinesthetic competence is, by definition, expressed through physical manipulation, demonstration and procedural skill, none of which a paper-based test captures; the true predictive strength of kinesthetic learning style on Integrated Science achievement is therefore likely understated by the coefficients reported here, and future iterations of this research should incorporate practical performance assessment, such as laboratory practical scores, project work or teacher-rated practical rubrics, as part of the dependent variable to test this possibility directly. A fourth cause is age and CBE-implementation maturity: the comparison studies typically examined senior secondary learners or higher-education contexts in jurisdictions with longer-established competency-based or learner-centered frameworks, whereas CBE in Kenya is still being operationalized in junior schools, and the predominantly early-career teacher workforce documented in the demographic analysis, of whom 90% had between one and ten years of experience, may not yet have developed the practical-instruction repertoire needed to consistently translate learner style preferences into differentiated, resource-intensive practical activities. In a rural sub-county such as Igembe South, this early-implementation profile compounds rather than operates independently of resource constraints, since a novice teacher working with an under-equipped laboratory has neither the pedagogical experience nor the physical materials to routinely stage the structured practical sessions that would allow kinesthetic preference to translate fully into measurable achievement; the modest effect sizes reported here should accordingly be read as a conservative, context-specific estimate rather than a ceiling on what visual and kinesthetic instruction can achieve once CBE implementation matures and laboratory resourcing improves. Fifth, the suppression of VL Score's individual coefficient by KL Score in the multivariate model is visible from the bivariate correlation ($r = .118$) collapsing to insignificance ($\beta = .109$) once KL Score is controlled for. This is a meaningful structural finding rather than a measurement artefact, indicating that in this context the two styles share substantial achievement-relevant variance, consistent with the moderate inter-predictor correlation.

It is important to contextualize the modest R^2 of .025 reported for the joint model directly, rather than treating it only as a statistical artefact of range restriction and assessment format. An R^2 of this magnitude means that learning style, even taken jointly across both modalities, accounts for a small fraction of the variance in Integrated Science achievement, and that the great majority of that variance is attributable to factors this study did not model. Systematic reviews of academic achievement predictors, including Suleiman et al. (2024) and Suhaini et al. (2020), consistently rank socio-economic status, teacher competence and instructional experience, and school-level resource availability, such as laboratory equipment, textbooks and class size, among the strongest predictors of learner performance, typically explaining substantially more variance than learning style preference alone. In the Igembe South context specifically, where the demographic profile documented an overwhelmingly early-career teaching workforce and where rural schools face well-documented constraints in laboratory and visual-aid provisioning, it is plausible that socio-economic status and resource availability are doing much of the explanatory work that a two-predictor learning-style model cannot capture. This reframing does not diminish the substantive finding that kinesthetic learning style significantly predicts achievement; rather, it situates that finding accurately as one modest but genuine contributor operating alongside larger, unmeasured structural predictors, and it cautions against interpreting the low R^2 as evidence that learning style is unimportant, when the more accurate reading is that learning style is one of several contributors whose full effect is likely constrained by the same resource and experience limitations documented elsewhere in this study.

Two methodological refinements would help isolate how much of the unexplained variance is attributable to the learning-style construct itself, as opposed to omitted predictors. First, this study examined only visual and kinesthetic modalities, on the grounds that existing literature most strongly associates these two with science learning, leaving auditory and read/write modalities out of scope; expanding future iterations of this model to the full VARK framework would test whether the modest R^2 reflects a genuine ceiling on what learning style can explain, or whether auditory and read/write preferences are absorbing achievement-relevant variance that a two-modality model necessarily misses. Second, the moderate inter-predictor correlation observed between VL Score and KL Score (approximate $r \approx .33$) and the suppression of the visual coefficient once kinesthetic learning is controlled for both suggest that the two styles may not operate purely additively. Future revisions of this model should incorporate a visual-by-kinesthetic interaction term to formally test for instructional synergy, that is, whether learners who score highly on both modalities simultaneously achieve disproportionately better outcomes

than an additive model predicts, which would provide statistical confirmation of the qualitative finding that teachers consider the two styles most effective when used together.

Wan Hussin (2023) and Chikendu and Chukwunazo (2022) both observed that visual and kinesthetic learning function more effectively in combination than in isolation, and the present regression coefficients corroborate this by showing significant joint prediction even when the individual visual contribution is suppressed. The implication for instructional practice in Igembe South Sub-County is therefore that the most promising pedagogical approach is not to choose between visual and kinesthetic strategies, but to integrate them, particularly through structured practical activities that simultaneously engage both learning styles, an approach for which Ahmad et al. (2023) and Kebaso (2023) provide clear precedent.

CONCLUSION

Based on the objective of the current study, the results provide empirical support for Competency Based Education's joint emphasis on observation and investigation, within the broader context of teaching and learning Integrated Science in Igembe South Sub-County, Meru County, Kenya. This suggests that improving learner outcomes in Integrated Science depends less on favouring one learning style over the other and more on establishing instructional conditions where both visual and kinesthetic styles are activated simultaneously, supported by classrooms with sufficient resources and pedagogically trained teachers. Among the two learning styles examined, the predictive model concluded that kinesthetic learning style was the more reliable individual predictor of academic achievement. Both learning styles examined in this study showed significant prevalence among Grade 8 learners in Igembe South Sub-County, and together they jointly and significantly predict academic achievement in Integrated Science. It should, however, be concluded with appropriate caution that learning style is one modest contributor among several, since the joint model explained only 2.5% of the variance in achievement; factors such as socio-economic status, teacher competence and school-level resource availability, none of which this study modelled, are likely to account for a considerably larger share of learner performance, and the present findings should be read as evidence that visual and kinesthetic learning style matter, not that they are the dominant determinants of achievement in Integrated Science.

RECOMMENDATIONS

The study recommends that Integrated Science teachers in Igembe South Sub-County integrate visual and kinesthetic learning strategies within the same lessons, combining practical exercises, laboratory activities, fieldwork and model-making with diagrams, charts, demonstrations and concept maps. Since kinesthetic learning was the stronger individual predictor of academic achievement, teachers should make practical and learner-centered instructional activities regular components of instruction and use locally available materials where laboratory resources are limited. Because the early-career profile of the Integrated Science teaching workforce documented in this study suggests that CBE implementation in rural Igembe South is still maturing rather than fully established, school administrators and boards of management should treat the equipping of science laboratories with basic apparatus, visual teaching aids and practical materials as a foundational rather than discretionary priority, and should organize structured in-service training, school-based workshops and peer learning sessions on differentiated and learning-style-responsive pedagogy so that early-career teachers can build the practical-instruction repertoire that CBE's observation- and investigation-based orientation assumes. Curriculum designers and the Kenya Institute of Curriculum Development (KICD) should develop lesson plans and instructional materials that explicitly integrate visual and kinesthetic activities rather than treating them as separate methodological choices, while the Ministry of Education and policy-makers should strengthen the provision of science laboratory resources in rural junior schools and promote practical and project-based assessment, such as laboratory practicals and project work, alongside theoretical examinations, since written examinations alone are poorly suited to capturing the procedural and hands-on competencies that kinesthetic instruction is intended to develop.

Suggestions For Further Research

This study, while making meaningful contributions to the understanding of learning styles and academic achievement in junior schools in Igembe South Sub-County, has scope and methodological boundaries that point to several productive directions for future research. The study was confined to ten purposively sampled schools in a single rural sub-county in Meru County, which limits the generalizability of the findings to other geographical and resource contexts within Kenya. Replication of the study across other sub-counties and counties, particularly comparative studies between resource-rich and resource-constrained settings, would directly test the contextual moderation hypothesis advanced in this study, namely that the magnitude of learning style effects on academic achievement is partly a function of instructional resource availability.

The two-predictor model deployed in this study, while theoretically justified by the literature's strongest association of visual and kinesthetic styles with science learning, leaves auditory and read/write modalities unexamined and cannot rule out that these omitted modalities are absorbing achievement-relevant variance. Future iterations of this research would benefit from expanding the framework to encompass all four VARK modalities, which would clarify the relative contribution of each learning style and address the omitted-variable concern raised by the modest R^2 obtained here. Relatedly, given the moderate positive association observed between the visual and kinesthetic predictors and the suppression of the visual coefficient once kinesthetic learning was controlled for, future regression models should incorporate a visual-by-kinesthetic interaction term to formally test for instructional synergy between the two styles, rather than assuming a purely additive relationship.

A further limitation concerns the operationalization of academic achievement itself. This study relied solely on end-of-term theoretical examination scores as the dependent variable, after Continuous Assessment Test records and class-level means were excluded for inconsistent availability across schools. Because kinesthetic competence is expressed primarily through physical manipulation, procedural skill and hands-on demonstration, a written theoretical examination is not well suited to capturing the outcomes that kinesthetic instruction is theoretically expected to produce, and the kinesthetic coefficient reported here is therefore likely a conservative estimate of the true relationship. Future research should incorporate practical performance assessment, such as laboratory practical scores, project-based assessment and teacher-rated practical rubrics, into the dependent variable to test whether the kinesthetic advantage grows once assessment more fully captures practical competence, as Edulan et al. (2022) similarly recommend.

ACKNOWLEDGMENT

The authors wish to thank the school administrators, Integrated Science teachers and Grade 8 learners in Igembe South Sub-County who participated in this study, as well as Tharaka University for its academic support throughout the research process.

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