



Parental Provision of Learning Resources and Students' Academic Achievement in Science Subjects among Day Secondary Schools in Vihiga Sub-County, Kenya

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Abstract: Science education is essential for driving national technological innovation and global competitiveness. This study examined the relationship between parental provision of learning resources and students' academic achievement in science subjects among public day secondary schools in Vihiga Sub-County, Kenya. Anchored on Epstein's Theory of Overlapping Spheres of Influence, the study adopted a correlational research design. A sample of 341 students and 126 science teachers was selected using stratified and simple random sampling techniques. Data were collected via structured questionnaires and document analysis. Pearson's correlation revealed a positive and statistically significant relationship ($r = 0.569, p < .001$). Hierarchical multiple regression analysis confirmed that parental provision of learning resources significantly predicted science academic achievement ($B = 6.726, p < .001$) after controlling student- and teacher-level factors. The study concludes that material home support independently enhances science outcomes and recommends that education stakeholders establish school-home partnerships to guide parents in providing specialized science learning resources.

Keywords: Parental involvement, Science academic achievement, Learning resources, Day secondary schools

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1. Introduction

Globally, governments increasingly view science education as a strategic instrument for economic transformation and global competitiveness. Science subjects such as Chemistry, Physics, and Biology equip learners with analytical skills, problem-solving capacity, and innovative thinking necessary for industrial growth and technological advancement. The World Bank (2023) reports that over 20 percent of public education expenditure in many developing countries is directed toward STEM-related programs, reflecting the growing recognition of science education as a development priority. Similarly, UNESCO (2022) notes that countries allocating at least one percent of GDP to research and development experience significantly faster industrial growth.

Advanced economies such as South Korea and Germany demonstrate how sustained investment in science education strengthens national competitiveness (OECD, 2021). However, research increasingly shows that infrastructure development and curriculum reforms alone do not guarantee improved science achievement. Epstein (2018) argues that persistent low performance in science often reflects broader ecosystem challenges beyond classroom instruction.

Countries such as Singapore, Finland, Japan, the United States, and the United Kingdom illustrate how parental engagement complements systemic STEM reforms. In Singapore, sustained funding for laboratories, teacher professional development, and national competitions is paired with strong parental support structures (Ng, 2020). In the United States, parental involvement includes homework supervision, science-related discussions, and

participation in structured school programs such as STEM family nights (Fan & Williams, 2010; Gonzalez & Jackson, 2021). Finland emphasizes inquiry-based learning supported by close collaboration between teachers and parents (Sahlberg, 2015). In Japan, cultural expectations encourage parents to invest in after-school tutoring programs known as *juku* to reinforce science learning (Entrich, 2018; Shimizu, 2019). Similarly, in the United Kingdom, government-backed initiatives such as STEM Learning UK provide resources to parents to support home-based science engagement (Archer et al., 2013; DeWitt & Archer, 2015; Moote et al., 2020). Despite these structured efforts, disparities in science performance persist globally, particularly in under-resourced and rural settings. Evidence consistently indicates that parental engagement remains a significant determinant of student motivation and achievement in science disciplines (Wang & Degol, 2017). However, the implementation of meaningful parent-school partnerships remains uneven across contexts.

Across Africa, STEM education is increasingly prioritized as a driver of industrialization and sustainable development. However, structural inequalities continue to shape science outcomes. In Nigeria and Ghana for instance, financial limitations restrict parents' ability to provide textbooks, tutoring, and enrichment opportunities (Duyilemi & Bolaji, 2019). Nevertheless, parents frequently offer verbal encouragement and informal guidance regarding science careers (Adu & Orivel, 2022). In Ghana, community-based initiatives supporting science fairs and practical projects have strengthened parental engagement at the grassroots level (Ampiah & Adu-Yeboah, 2021). South Africa presents a similar pattern of inequality. While the Department of Basic Education promotes parental engagement, middle-class families are more likely to provide structured academic support and monitoring (Mncube, 2019). Low-income families often lack material resources, though informal mentorship and community science programs partially compensate for these gaps (Jansen, 2020; Spaull, 2019). These disparities underscore the intersection between socioeconomic status and effective parental involvement in science education.

In Kenya, science education remains central to national development policy. The government has implemented reforms such as the STEM Education Policy (2018) and strengthened institutional support through CEMASTEa to improve science teaching and laboratory infrastructure. These initiatives reflect the country's commitment to building a knowledge-based economy (MoE, 2022). However, disparities in science achievement persist across geographic and socioeconomic divides. In urban and well-resourced settings, parents are more likely to provide textbooks, finance private tuition, monitor homework, and actively participate in school activities (Waweru & Mugo, 2021). In contrast, rural regions, including parts of Western Kenya, face barriers such as financial hardship, limited

STEM awareness, and inadequate educational resources (Ochieng & Wambua, 2020). Gender dynamics further shape parental engagement patterns. Mothers frequently assume responsibility for homework supervision, while fathers often influence career aspirations and attitudes toward technical disciplines. These differentiated roles affect students' motivation and long-term orientation toward science subjects. Despite ongoing reforms, limited and inconsistent parental involvement continues to constrain the effectiveness of STEM initiatives. The persistence of uneven science performance, despite policy investment and institutional reforms, suggests that parental involvement remains a critical yet insufficiently understood factor within the Kenyan context. A systematic examination of how parental engagement influences students' performance in science subjects is therefore necessary to inform targeted and context-sensitive interventions.

In Vihiga Sub-County, where the study is focused, day secondary schools face unique challenges in STEM education. Many parents, especially in low-income households, are unable to provide necessary learning materials or actively monitor their children's academic progress due to work commitments and economic hardships (Owino & Musau, 2021). Additionally, cultural perceptions prioritizing traditional career paths over STEM-related fields further discourage students from pursuing science and technology subjects (Nyaboke et al., 2020). Given these contextual factors, this study is necessary to examine the extent of parental involvement and its relationship with students' STEM performance, providing insights for policymakers and educators to enhance parental engagement strategies in the region.

1.1 Problem Statement

The Government of Kenya has invested heavily in strengthening STEM education through institutions like CEMASTEa to support laboratory improvement and teacher professional development (CEMASTEa, 2020). At the county level, initiatives like the Vihiga Governor's Scholarship Programme have been introduced to expand access to academic support (Vihiga County Government, 2024a). Despite these interventions, science performance in public day secondary schools in Vihiga Sub-County remains persistently low, with school mean averages dropping below the grading scale midpoint across Biology, Chemistry, and Physics. While policy remedies largely focus on school infrastructure and instructional quality, less empirical attention has been directed toward home-based resource provision. The persistence of low science mean scores suggests a mismatch between school-side academic adjustments and home-side support structures. Without localized quantitative data on how parental provision of learning resources independently correlates with outcomes, interventions risk ignoring a core

environmental determinant of student mastery. This study addresses this gap by isolating and examining the direct relationship between parent-provided materials and academic science achievement in Vihiga Sub-County.

1.2 Aim and Hypothesis

The main aim of this study was to evaluate the relationship between parental provision of learning resources and students' academic achievement in science subjects among public day secondary schools in Vihiga Sub-County, Kenya. The study was guided by the following null hypothesis:

H01: Parental provision of learning resources has no significant relationship with students' academic achievement in science subjects among public day secondary schools in Vihiga Sub-County.

2. Literature Review

This section presents a critical review of existing literature concerning the impact of parental provision of learning resources on learners' achievement in science disciplines. Science subjects demand substantial practical exposure, conceptual reinforcement, and independent study home environments. Consequently, home supply variations can produce distinct academic outcomes. This thematic review focuses on physical, digital, and instructional resources supplied by parents, highlighting contextual contradictions and identifying the analytical gaps that motivated this inquiry.

2.1 Theoretical Underpinning

This study was anchored on Joyce L. Epstein's (2011) Theory of Overlapping Spheres of Influence. Epstein argues that the primary institutional environments shaping student development- the family, the school, and the community- do not operate in isolation. Instead, they interact dynamically to create an integrated support network around the learner. At the center of these overlapping spheres is the student, whose academic potential and behavioral orientation toward science are deeply affected by structural partnerships across these boundaries. Within this framework, parental provision of learning resources represents a vital family-sphere mechanism that reinforces the institutional goals of the school sphere. When parents provide textbooks, stationery, and study spaces at home, they align home conditions with classroom pedagogical demands, allowing science competencies to develop seamlessly.

2.2 Empirical Literature

Parental provision of learning materials remains a key aspect of involvement that directly influences attitude

towards science subjects where students must engage both theoretically and practically. The availability of essential resources like textbooks, revision guides, science kits, and digital tools can significantly shape how students' access, interact with, and retain scientific knowledge.

A study by Nzioka and Odhiambo (2023), which explored the role of parental provision of science textbooks in Kenyan day secondary schools, found that students with personal access to science textbooks had better attitudes and performance in national science exams than their peers relying solely on shared school materials. On average, students with private resources scored 15–20% higher. However, their study focused primarily on semi-urban areas, missing the nuanced challenges in rural contexts. The current study in Vihiga Sub-County addresses this by focusing specifically on rural schools, thereby offering a broader understanding of how resource availability affects learners in less developed settings.

Digital learning materials are also becoming increasingly important, especially with the growing integration of ICT in science education. A quasi-experimental study by Akinyemi and Ouma (2024) found that students with parental access to digital resources, such as simulations, virtual labs, and video tutorials, achieved significantly better understanding of complex science concepts. Their research, however, was limited by assumptions of universal digital literacy and stable internet access. In contrast, the current study recognises the digital divide and aims to assess the role of both digital and analogue materials in a low-resource, rural context.

Hands-on learning tools provided at home, such as mini-laboratory kits, have also shown a strong correlation with improved performance in science practicals. In a recent longitudinal study, Mahlangu and Dlamini (2023) reported that students with consistent access to home-based practical materials showed enhanced scientific reasoning and scored 18–22% higher in lab-based assessments. While this study highlighted the value of tactile engagement, it lacked a detailed socio-economic breakdown. The present research expands on this by integrating household income and parental education levels to understand their moderating effect on science performance.

Supplementary resources such as revision books, encyclopaedias, science magazines, and parental support in securing such materials have also been linked to academic success. According to Ameyaw and Tandoh (2024), students in Ghana who received structured parental support through supplementary science texts outperformed their peers by nearly 20% on average. Yet, their research did not account for how effectively these materials were used at home. The current study includes this dimension by investigating how actively parents supervise or support the use of learning resources beyond simply providing them.

Private tuition, funded or arranged by parents, also plays a significant role in enhancing science performance. In a Kenyan study, Ochieng and Ndungu (2021) found that students receiving consistent extra coaching in science subjects scored significantly higher, by an average of 17%, compared to those who relied solely on classroom instruction. However, their study was largely tuition centred. The current research shifts focus to compare whether parental provision of learning resources alone, without tuition, can yield similar improvements in performance. This approach helps explore the cost-effectiveness and accessibility of different parental involvement strategies in resource-constrained settings.

In sum, the reviewed literature shows that the availability and use of parent-provided learning materials have a positive impact on students' academic achievement in science. However, there are still gaps, particularly around rural settings, the influence of socio-economic status, and the comparative value of materials versus paid support. This study addresses those gaps by focusing on the rural context of Vihiga Sub-County, incorporating digital access, and analysing background factors that influence how resources are used.

3. Methodology

3.1 Study Design

This study adopted a correlational research design to examine the relationship between parental provision of learning resources and students' academic achievement in science subjects. Correlational research is non-experimental and evaluates naturally occurring statistical relationships between variables without experimental manipulation (Gay et al., 2012). This design is highly appropriate for educational research investigating home environmental characteristics and performance, as it permits the evaluation of structural associations using continuous data arrays within normal ecological constraints.

3.2 Location and Justification

The study was conducted in Vihiga Sub-County, situated in the Western region of Kenya. This location was purposively selected due to a persistent five-year trend of low student performance in science subjects in local day secondary schools. The sub-county is predominantly rural, and the local economy relies heavily on subsistence

farming, which translates to low and unpredictable household incomes (KNBS, 2019). These unique socioeconomic conditions provide an ideal testing ground for evaluating how home material support influences academic outcomes within resource-constrained environments.

3.3 Population and Sampling

The target population comprised 9,540 students and approximately 220 science teachers across 36 public day secondary schools in Vihiga Sub-County. Day schools were selected because their students live at home, meaning they experience direct and ongoing parental interactions. Sample sizes were calculated using Israel's (2001) formula for finite populations. This yielded a sample size of 384 students and 142 science teachers drawn from 33 day schools to ensure regional representation. Stratified random sampling was applied across class levels (Forms 3 and 4) and school categories, while simple random sampling was used to select individual student and teacher respondents. Final clean datasets for this specific objective were obtained from 341 students and 126 science teachers, representing an operational response rate of 88.8%.

3.4 Instruments and Data Analysis

Primary data were gathered using structured Likert-scale questionnaires administered to students and teachers, while secondary data were extracted from official school progress records using a document analysis guide. The parental provision scale comprised six items (LR1–LR6) tracking textbook supply, revision allocations, stationery, references, practical kits, and home study tools. Statistical analyses were completed using SPSS. Exploratory Factor Analysis (EFA) was used to test the unidimensionality of the parental resource provision scale, and Cronbach's alpha evaluated internal reliability. Inferential analysis progressed from bivariate Pearson pairwise correlation to Hierarchical Multiple Linear Regression (MLR). The fully adjusted model controlled for student gender, age, form level, teacher teaching experience, teacher professional qualification, and school science learning resources.

4. Results and Discussion

4.1 Descriptive Findings and Factor Analysis

Table 1: Descriptive data of students' performance parameters across the core science disciplines

Measure	N	Min	Max	Mean	SD
Biology Score (%)	341	18.00	82.00	48.36	13.27
Chemistry Score (%)	341	15.00	79.00	44.72	14.18
Physics Score (%)	341	20.00	85.00	51.64	12.91
Overall Science Academic Achievement (%)	341	19.00	82.00	48.24	12.36

The baseline performance results reveal a relatively low overall science average ($M = 48.24\%$, $SD = 12.36$). Physics recorded the highest subject mean (51.64%), while

Chemistry was the lowest (44.72%). The wide standard deviations indicate substantial performance variations among students across the sub-county.

Table 2: Item-level scores for the independent scale framework tracking parental provisions

Code	Item Statement	Mean	SD
LR1	My parent(s)/guardian(s) provide me with the required textbooks for learning science subjects	3.42	1.18
LR2	My parent(s)/guardian(s) provide money for purchasing science revision materials	3.31	1.24
LR3	My parent(s)/guardian(s) ensure that I have adequate stationery for learning science subjects	3.67	1.09
LR4	My parent(s)/guardian(s) provide or facilitate access to science reference materials	3.18	1.27
LR5	My parent(s)/guardian(s) support me in obtaining materials required for practical science activities	3.05	1.31
LR6	My parent(s)/guardian(s) provide resources that	3.54	1.15

Item descriptive patterns indicate that parents provided basic stationery (LR3: M = 3.67) and home-study spaces (LR6: M = 3.54) more consistently than specialized reference materials (LR4: M = 3.18) or practical equipment (LR5: M = 3.05).

To construct the independent composite variable, the items were analyzed using Principal Component Analysis

(PCA). The sample met validity requirements, with a Kaiser-Meyer-Olkin (KMO) value of 0.867 and a highly significant Bartlett's Test of Sphericity ($\chi^2 = 687.821$, $df = 15$, $p < .001$). A single dominant factor emerged (Eigenvalue = 3.321), explaining 55.35% of the total variance.

Table 3: Factor loadings

Item	Factor Loading	Communality (h^2)	Uniqueness (u^2)
LR1	0.778	0.605	0.395
LR2	0.790	0.625	0.375
LR3	0.660	0.436	0.564
LR4	0.769	0.591	0.409
LR5	0.681	0.463	0.537
LR6	0.775	0.601	0.399

Factor loadings were strong, ranging from 0.660 to 0.790. Scale integration was confirmed by a strong Cronbach's alpha ($\alpha = 0.836$), validating the creation of a reliable composite variable (PRL).

4.2 Associations (Bivariate Findings)

A bivariate Pearson product-moment correlation was calculated to determine the linear association between parental resource provision and science performance.

Table 4: Pearson product-moment correlation Coefficients

Variable Array	1. Resource Provision	2. Science Achievement
1. Parental Provision of Learning Resources (PRL)	1.000	—
2. Science Academic Achievement (Y) [$p < .001$]	0.569	1.000

The correlation matrix reveals a positive, moderately strong, and statistically significant relationship between parental provision of learning resources and science academic achievement ($r = 0.569$, $p < .001$, $N = 341$). This indicates a strong linear trend: students whose families

provided more adequate educational resources achieved consistently higher mean scores across Biology, Chemistry, and Physics.

4.3 Regression Analysis and Hypothesis Testing

To isolate the independent relationship after adjusting for covariates, hierarchical linear regression models were estimated as presented in Table 5.

Table 5: Regression

Predictor Parameter	Model 1 B	SE	Beta	Model 2 B	SE	Beta
(Constant)	27.119	2.191	—	21.805	8.066	—
Parental Resources (PRL)	6.766	0.643	.496***	6.726	0.619	.493***
Student Gender (Female)				2.960	0.993	.136**
Student Age (Years)				-0.586	0.453	-.059
Form Level (Form 4)				2.551	0.993	.117*
Teacher Experience (Years)				0.228	0.103	.102*
Teacher Qualification				2.423	1.053	.105*
School Science Resources				1.610	0.535	.137**
R ² Variance Explained	0.246			0.319		
Model F-Statistic	110.78		(p < .001)	22.28		(p < .001)

Model 1 (unadjusted) shows that parental provision of learning resources alone accounts for 24.6% of the variance in science achievement ($R^2 = 0.246$, $F = 110.78$, $p < .001$). In Model 2, the explanatory power rose to 31.9% ($R^2 = 0.319$, Adjusted $R^2 = 0.305$, $F = 22.28$, $p < .001$) after adjusting for the control factors. Crucially, the resource provision slope remained stable and highly significant ($B = 6.726$, $SE = 0.619$, $\beta = .493$, $t = 10.861$, $p < .001$).

Because the regression model demonstrates a highly significant relationship, the null hypothesis (H_0) is rejected.

4.4 Post-Estimation Diagnostics

Post-estimation diagnostic checks were performed to ensure model stability.

Table 6: Multicollinearity Test

Regression Predictor Array	Tolerance Metric	VIF Index
Parental Provision of Learning Resources (PRL)	0.642	1.558
Student Gender	0.914	1.094
Student Age	0.746	1.340
Form Level	0.802	1.247
Teacher Teaching Experience	0.713	1.402
Teacher Professional Qualification	0.776	1.289
School Science Learning Resources	0.653	1.531

All tolerance parameters exceeded the 0.10 threshold, and VIF indices remained safely below the conservative threshold of 5.0 ($1.094 \leq \text{VIF} \leq 1.567$). This confirms the absence of problematic multicollinearity. Residual density patterns approximated normal curves, and linearity was verified using residual distributions.

4.5 Discussion of Results

The findings demonstrate that parental provision of learning resources significantly and positively impacts science performance in public day secondary schools in Vihiga Sub-County. This positive relationship aligns with the empirical conclusions of Nzioka and Odhiambo (2023), who found that personal science textbook access in day schools improved national exam grades by 15% to 20% compared to relying on shared school sets. These results also support Mahlangu and Board's (2023) research, which noted that home access to practical science guides significantly enhanced exam performance. Finally, these results offer a fresh perspective compared to studies that emphasize expensive private tutoring as the primary driver of science success (Ochieng & Ndungu, 2021). Providing physical learning materials serves as a sustainable alternative for boosting science outcomes within rural day secondary school systems.

5. Conclusion and Recommendations

5.1 Conclusion

This study demonstrates that parental provision of learning resources is an influential and independent predictor of student academic achievement in science subjects within public day secondary schools in Vihiga Sub-County. The statistical significance of the resource variable across all

regression models confirms that home material support heavily conditions student success, independent of classroom teaching quality or school laboratory resources. The study highlights that family investment is most effective when it matches the demands of the science curriculum.

5.2 Recommendations

Based on these findings, the following recommendations were proposed:

1. School administrations and Board of Management (BOM) units should create structured orientation programs for parents. These sessions should provide clear checklists of essential science materials, such as revision booklets and basic practical tools, helping families prioritize educational purchases that match their budgets.
2. Sub-County education authorities, working alongside school science departments, should design community sensitization initiatives. These programs should inform parents about the critical value of providing targeted learning resources at home, particularly for practical subjects like Chemistry, Physics, and Biology.
3. To support low-income families, schools should set up low-cost book-sharing systems or provide community access to digital reference platforms. This ensures that day school learners can easily obtain science resources for independent study outside regular school hours.

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