Journal of Education Management and Leadership

[ISSN 2958-1109]
Volume: 05 Issue: 01 | November-2026

JEML

Leadership or Resources? Reassessing the Institutional Drivers of Inquiry-Based STEM Learning in Nairobi's International Schools

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Cite this article in APA
Apiri, J. N., Oloo, M., & Ayiro, L. P. (2026). Leadership or resources? Reassessing the institutional drivers of inquiry-based STEM learning in Nairobi's international schools. *Journal of education management and leadership, 5*(1), 397–414. https://doi.org/10.51317/cg1mnm52

OPEN ACCESS
A publication of Editon Consortium Publishing (online)

Article history
Received: 2026-09-14
Accepted: 2026-10-07
Published: 2026-11-10

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Abstract
This study examined the relative associations of teacher-related factors, school-related factors, student-related factors, and instructional strategies with performance in STEM subjects in international schools in Nairobi, Kenya. Little is known about how strongly school leadership-related conditions relate to STEM performance compared with teacher-related, student-related, and instructional factors. The study employed a quantitative correlational design. Sample sizes were derived using Yamane's (1967) formula (16 schools from a population of 47 at a 20% margin of error) and Fisher's formula for proportions (about 67 students and 67 teachers at a 90% confidence level and a 10% margin of error), with the confidence levels and margins of error set for feasibility. Inferential analyses used the student-level dataset (N = 57) and employed Pearson correlation and multiple regression. The study found that teacher-related factors (β = .329, p = .001) and school-related factors (β = .318, p = .003) had the largest standardised coefficients, followed by instructional strategies (β = .266, p = .007) and student-related factors (β = .200, p = .040). The study concluded that school-related factors were positively associated with STEM performance among international schools in Nairobi, suggesting that leadership and institutional capacity may support inquiry-based STEM learning. It recommends that school leaders embed inquiry in lesson-planning requirements, supervision, and appraisal, and that policy bodies consider instructional leadership preparation as a complement to teacher training. The study provides comparative evidence on the relative associations of school-related conditions with STEM performance in a comparatively well-resourced African setting.

Key terms: Inquiry-based learning, international schools, Kenya, school leadership, STEM education.

1.0 INTRODUCTION

This study examined the relative associations of teacher-related factors, school-related factors, student-related factors, and instructional strategies with performance in STEM subjects in international schools in Nairobi, Kenya. Inquiry-based learning (IBL) is widely promoted as an approach to developing the critical thinking, creativity, and problem-solving competencies required in a knowledge-based economy (Nghiem et al., 2025). In Science, Technology, Engineering, and Mathematics (STEM) education, IBL emphasises applying content knowledge through questioning, investigation, evidence evaluation, and problem-solving (Anthony et al., 2021; Chu et al., 2017). Kenya's Competency-Based Curriculum (CBC) similarly emphasises learner-centred education and competency development, positioning teachers as facilitators of learning rather than solely as transmitters of content (Kenya Institute of Curriculum Development [KICD], 2017). However, adopting learner-centred policies does not necessarily ensure consistent classroom implementation. Research has identified challenges in translating inquiry-oriented educational goals into instructional practice (Cunningham, 2024; Roslan et al., 2023). School leadership is relevant to this challenge because decisions concerning instructional priorities, resource allocation, teacher support, and school organisation may influence the conditions under which inquiry-based instruction is implemented (Hallinger & Heck, 1998; Louis et al., 2010).

Despite growing interest in instructional leadership and inquiry-based STEM education, the relative association of school-related factors with STEM performance, compared with teacher-related factors, student-related factors, and instructional strategies, remains insufficiently established in the specific context of international schools in Africa. Previous research provides important but different perspectives on these relationships. Hallinger and Heck (1998) reviewed evidence on the relationship between principal leadership and school effectiveness, highlighting the importance of indirect pathways through school conditions and instructional processes. Similarly, Louis et al. (2010) examined how school leadership relates to student learning through organisational and instructional processes, while Heck and Hallinger (2009, 2014) investigated leadership and school improvement using longitudinal and multilevel approaches. This body of work provides a basis for understanding leadership as an influence that may operate through the school environment and classroom practice. However, these studies do not, by themselves, establish the relative strength of the association between school-related factors and STEM performance when teacher-related factors, student-related factors, and instructional strategies are examined simultaneously in the context investigated here.

Research examining science achievement alongside school and instructional characteristics also offers relevant evidence. For example, Tan et al. (2020) examined school leadership and other educational factors in relation to science outcomes using an international comparative context. Nevertheless, evidence from large-scale international assessments does not automatically establish how leadership-related conditions compare with teacher, student, and instructional factors in inquiry-oriented STEM learning within international schools in an African setting. Hattie (2009) synthesised evidence on influences associated with student achievement. Still, that synthesis does not replace estimating the comparative associations of the four predictor categories within one model using data from the same study population. In addition, research on leadership for science and STEM education has addressed leadership practices and their implications for instructional improvement (Adams & Hamdhiyya, 2022; Wooley, 2025), while Gatama et al. (2023) examined instructional leadership in relation to national examination performance in Kenyan public schools. These studies provide useful foundations, but their contexts and analytical emphases differ from the present study. Accordingly, the present research addresses a context-specific evidence gap by

examining teacher-related factors, school-related factors, student-related factors, and instructional strategies together in relation to STEM performance in international schools in Nairobi County. This gap is defined by the combination of the study population, predictor categories, and outcome examined, rather than by the claim that previous research has not investigated leadership or educational factors collectively.

The relationship between school-related factors and STEM performance merits particular attention because school-level decisions may shape the conditions under which classroom instruction occurs. Budget allocation, staffing, class size, laboratory and information and communication technology provision, protected planning time, professional development, and the organisational climate surrounding instructional experimentation may enable or constrain teachers' use of inquiry-based approaches. These conditions may also influence the opportunities available to students to participate in practical investigations and collaborative problem-solving. Consequently, examining school-related factors alongside teacher-related factors, student-related factors, and instructional strategies can help establish whether school-related conditions have a distinct statistical association with STEM performance within the study population. Such comparisons can inform discussions about instructional leadership and resource allocation. However, correlational findings cannot establish causal effects or determine whether school-related factors operate indirectly through teacher capacity and classroom practice.

International schools in Nairobi County provide a specific institutional context for investigating these relationships. Such schools may operate under international curricular frameworks, including Cambridge International, American curricula, and the International Baccalaureate, and may differ from public schools in their organisational arrangements, staffing, instructional resources, and approaches to professional development. These characteristics should not, however, be assumed to be uniform across the sampled schools. Furthermore, the present study did not measure or statistically control for resource availability; therefore, the analysis cannot establish whether school-related factors are associated with STEM performance independently of resource levels. Rather, the setting allows the study to examine variation in school-related conditions within a population of international schools, without assuming that these schools share the same resource profile or that the findings isolate leadership effects from material resources.

The CBC provides a relevant national policy reference because its emphasis on learner-centred teaching and competency development overlaps with important principles of inquiry-based STEM education (KICD, 2017). However, the sampled international schools are described as operating under international curricula, and CBC implementation was not measured. The study therefore does not assess CBC implementation or effectiveness, nor does it assume the sampled schools implement CBC requirements. Instead, its findings may offer cautious, indirect insights for Kenyan education policymakers and school leaders considering the organisational conditions that support inquiry-oriented STEM instruction. Applying these findings to CBC schools would require further investigation, particularly because differences in resources, governance, teacher preparation, and curricular requirements may affect their relevance.

Against this background, the study examined the associations between four categories of factors and STEM performance in international schools in Nairobi County: teacher-related factors, school-related factors, student-related factors, and instructional strategies. The study paid particular attention to the school-related category, including leadership, resourcing, and institutional or policy-related conditions, to determine how its association with STEM performance compared with those of the other predictor

categories. The study had four specific objectives: to determine the association between teacher-related factors and STEM performance; to examine the association between school-related factors and STEM performance; to establish the association between student-related factors and STEM performance; and to assess the association between instructional strategies and STEM performance. By examining these categories in a single regression model, the study provides comparative evidence on their statistical associations within the sampled schools. It also offers context-specific evidence that may inform discussions of instructional leadership and the conditions needed to support inquiry-based STEM instruction, while recognising the limits of generalisation beyond the study population.

The study employed a quantitative correlational design. Questionnaires were administered to students, STEM teachers, and head teachers in 16 international schools in Nairobi County. Student-level data for 57 students (N = 57) were analysed using Pearson correlation and multiple regression to examine the associations between the four predictor categories and STEM performance. The study presents the theoretical framework and review of related literature, describes the research methodology, reports and discusses the findings, sets out recommendations and limitations, and concludes.

2.0 LITERATURE REVIEW

Theoretical Framework

Constructivist and Experiential Foundations

The study was grounded in constructivist learning theory (Piaget, 1980; Vygotsky, 1962) and experiential learning theory (Kolb, 1984), which builds on Dewey's (1938) progressive-education tradition. Three principles from these theories link constructivism to inquiry-based STEM learning. First, learners construct understanding by acting on problems rather than by receiving content (Piaget, 1980). Second, understanding develops through social interaction and guided support (Vygotsky, 1962). Third, learning is a cycle of concrete experience, reflection, abstract conceptualisation, and active experimentation (Kolb, 1984). IBL applies these principles by asking learners to pose questions, investigate, and explain evidence.

Each principle points to a category of factors. Guided support makes teacher-related factors central, including inquiry expertise, confidence, and training. Learner-driven construction makes student-related factors important, including prior knowledge, motivation, and engagement. The experiential cycle depends on instructional strategies that provide tasks, materials, and time for reflection. These three categories operate inside the classroom. School-related factors, the fourth category, concern conditions classrooms cannot provide on their own: budget, laboratory and ICT provision, class size, protected planning time, professional development, and a culture that tolerates error.

Theoretical Assumptions and Propositions

The framework rests on four assumptions. First, learning is constructed by the learner through guided activity. Second, guided activity requires teachers who can facilitate inquiry. Third, inquiry tasks require instructional time, materials, and structure. Fourth, teachers, learners, and instructional design all operate within organisational conditions set by school leaders. These assumptions yield four propositions, each tied to one predictor category.

Proposition 1 concerns teacher-related factors. Because learners need guided support, teacher expertise, confidence, and professional development should be positively associated with STEM performance. Teachers who value inquiry but lack expertise and support are less able to provide that guidance (Margot

& Kettler, 2019; Twahirwa et al., 2022). Proposition 2 concerns student-related factors. Because learners construct understanding from what they already know, prior knowledge, motivation, and engagement should be positively associated with STEM performance (Ghawas et al., 2025; Nzomo et al., 2023).

Proposition 3 concerns instructional strategies. Because experiential learning requires structured tasks and reflection, guided and interactive strategies should be positively associated with STEM performance (De Jong et al., 2023; Kunalan et al., 2018).

Proposition 4 concerns school-related factors and the distinctive role of school leadership. Teacher, student, and instructional factors are exercised within classrooms. School leaders control the resources and routines they depend on: budget, staffing, class size, protected planning time, professional development, and tolerance for instructional risk (Mupa, 2023; Riddel & Zulfikar, 2024). Leadership therefore differs in kind from the other three categories. Theory allows two readings of this role. In the first, school-related factors are an independent input with their own association with STEM performance.

In the second, they are an enabling condition that works partly through teacher capacity and classroom practice. The correlational regression used here can estimate the relative strength of association, which bears on the first reading. It cannot test the second, which requires mediation analysis. Proposition 4 is therefore stated in terms the design can examine. If school-related factors are more than a peripheral input, they should show an association with STEM performance comparable in magnitude to that of teacher-related factors, even in a comparatively well-resourced setting.

Synthesis of the Theoretical Framework

The theoretical framework proposes that STEM performance is associated with four interrelated categories of factors derived from constructivist and experiential learning theories. Teacher-related factors reflect the guided support required for learners to construct knowledge; student-related factors represent learners' prior knowledge, motivation, and engagement; instructional strategies provide the structured experiences through which learners investigate, reflect, and apply knowledge; and school-related factors represent the organisational conditions that enable teachers and learners to engage in inquiry-based STEM learning. School leadership has a distinctive role because it influences the resources, professional support, instructional time, and organisational culture within which the other three categories operate. Accordingly, the study examines the associations between each of the four predictor categories and STEM performance, with particular attention to whether school-related factors demonstrate an association comparable in magnitude to that of teacher-related factors. Although school-related factors may also influence STEM performance indirectly through teacher capacity and classroom instructional practices, the correlational regression design examines their direct statistical associations rather than testing mediation. This theoretical synthesis provides the basis for the study's four propositions and the corresponding empirical model.

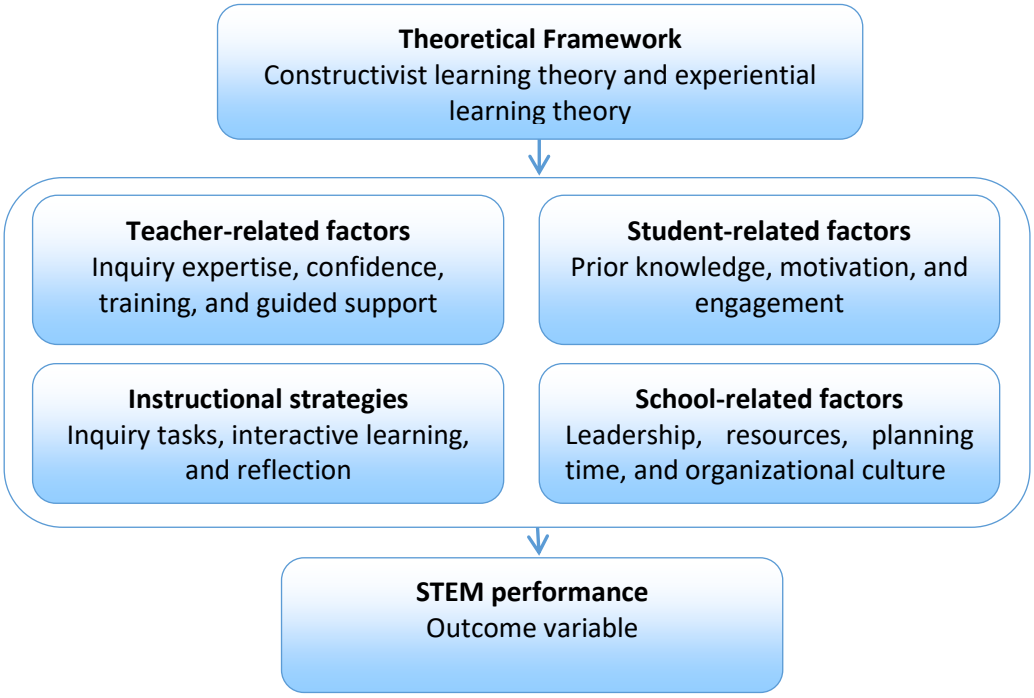


Figure 1: Theoretical Framework

Empirical Review

Leadership and Institutional Conditions

Several studies link school leadership to the conditions that support IBL, although most are qualitative, small-scale, or review-based. Mupa (2023), in a qualitative case study of a private academy in Zimbabwe, reported that effective school leaders provided a clear vision, developed teachers' pedagogical skills through supervision, maintained student discipline, and secured resources to reduce class sizes. In a systematic review, Riddel and Zulfikar (2024) concluded that innovative leaders foster cultures of collaboration, technology integration, and personalised learning, which were associated with higher engagement, motivation, and achievement. In STEM, Wooley (2025) used a modified Delphi panel to reach expert consensus on the knowledge, skills, dispositions, and practices effective STEM leaders need. Adams and Hamdhiyya (2022) reviewed 20 studies and identified seven themes of principal practice in science instruction, including curriculum monitoring, resources, distributed leadership, recruitment of science teachers, and teacher professional development. Evidence on how inquiry-based teaching relates to school conditions is mixed and indirect. Doboyou and Nyamu (2023) surveyed students and teachers in 11 secondary schools in Kiambu County. They reported that most students held positive attitudes toward biology under inquiry-based teaching and wanted more practical work, although fewer reported good performance. Gómez and Suárez (2020), using PISA 2015 data from Colombia, found that inquiry-based teaching was associated with lower science scores but higher self-reported critical thinking, and that school climate moderated these relationships.

Teacher, Student, and Instructional Conditions Associated with IBL

Three further groups of conditions are identified in the literature. The first is teacher capacity. In a review of 25 studies, Margot and Kettler (2019) found that teachers generally value STEM education but report

limited expertise and insufficient support. Twahirwa et al. (2022) surveyed 82 science teachers in Kirehe District, Rwanda. Teachers saw IBL as effective for practical skills and higher-order thinking, but named limited professional development, time, and resources as barriers. Sichangi (2024) examined the effect of inquiry-based learning on mathematics achievement in STEM-integrated secondary schools in Kenya. Using a Solomon four non-equivalent control group quasi-experiment, Sichangi reported that the inquiry-based learning indicators predicted post-test mathematics scores (coefficient of determination = .959), with prior knowledge, actual inquiry, and assessment emerging as significant predictors and explanation and application as non-significant ones. In a quasi-experimental study of 160 Physics students in four Kitui County schools, Kunga et al. (2022) found that students taught through inquiry outperformed control groups on a task-competence test. The second is student readiness and engagement. Nzomo et al. (2023) examined the relationship between inquiry-based learning and students' self-efficacy in Chemistry in Kenyan secondary schools. Ghawas et al. (2025) compared 600 elementary pupils in STEM-focused and non-STEM schools and reported higher engagement, teacher and peer interaction, and academic performance in the STEM-focused schools. The cross-sectional design does not isolate the effect of inquiry teaching. The third is instructional strategy. Kunalan et al. (2018) reported, from a qualitative inquiry, that interactive, technology-enabled strategies were associated with engagement and contextual understanding and depended on teachers' training and institutional support. De Jong et al. (2023) argued, in a review of evidence, that inquiry is most effective when guided and combined with direct instruction at appropriate points.

Studies Examining the Factor Groups Together

A smaller set of studies has examined leadership together with other factors. Hallinger and Heck (1998) reviewed 15 years of research on principals' effects and concluded that principals have a measurable but indirect effect on school effectiveness. Louis et al. (2010) reported strong, positive, although indirect, effects of leadership on student learning in US districts and schools. Heck and Hallinger (2009) modelled distributed leadership, school academic capacity, and growth in mathematics achievement in 195 US elementary schools. Heck and Hallinger (2014) found, in 60 US elementary schools, that the school's instructional environment mediated leadership effects on learning growth. Tan et al. (2020) combined principal leadership, teacher quality, science resources, and school and student socioeconomic status in a three-level analysis of PISA 2015 science data from 35 OECD countries. Gatama et al. (2023) related principals' instructional leadership to KCSE results in public secondary schools in Nyeri and Nyandarua counties; the combined leadership dimensions accounted for 16.7 per cent of the variation in achievement. Hattie (2009) synthesised more than 800 meta-analyses of influences from students, homes, schools, curricula, and teachers. These studies suggest that leadership matters, but mainly indirectly. To the authors' knowledge, none estimated the relative weight of leadership-related, teacher, student, and instructional factors for inquiry-based STEM performance, and none sampled international schools in Africa.

Research Gap and Research Question

Three limitations follow from this literature. First, leadership has been modelled mainly as an indirect influence, so its weight relative to teacher, student, and instructional factors is not reported in a comparable form. Second, the outcomes studied are generic achievement or science outcomes that are not tied to inquiry-based practice. Third, the settings are largely outside Africa or, where Kenyan, are public schools. The present study addresses these limitations only in part. It estimates the relative association of the four factor groups with STEM performance in a single model, in international schools in Nairobi. The

research question is: how strongly is each of the four factor groups associated with performance in STEM subjects, and are school-related factors associated with performance to a degree comparable to teacher-related factors? The design allows the strength of associations to be compared. It does not test whether leadership mediates or enables the effects of the other factors.

3.0 METHODOLOGY

The study adopted a quantitative, positivist, correlational design. The design suits examining naturally occurring relationships among teacher-related, school-related, and student-related factors, instructional strategies, and STEM performance. The target population comprised 47 international schools in Nairobi County. A school was eligible for inclusion if it was located in Nairobi County, offered the Cambridge, American, or International Baccalaureate curriculum, and taught STEM subjects to Grade 10 and 11 students. These criteria defined the study population and sampling frame. Although international schools may have better infrastructure than many public schools, resource levels were not measured in this study. Consequently, differences in resources across the participating schools were not statistically controlled for, and the findings should be interpreted within the context of the selected population.

The school sample size was determined using Yamane's (1967) formula, $n = N / (1 + Ne^2)$. Given a population of 47 schools and a margin of error of 20 per cent ($e = 0.20$), the sample size was calculated as $n = 47 / [1 + 47(0.20)^2] = 47 / 2.88 = 16.32$, resulting in a sample of 16 schools. The 20 per cent margin of error was accepted as a practical compromise because of time, financial, and logistical constraints, while keeping data collection manageable within available resources. A smaller margin of error would have required approximately 32 schools at 10 per cent and 42 schools at 5 per cent, increasing the demands on the study's resources. Nevertheless, the wider margin of error reduces the precision of school-level estimates, and this limitation is acknowledged in the study. The 16 schools were selected using simple random sampling from the sampling frame of 47 eligible international schools, giving each school an equal chance of selection.

The student and teacher sample sizes were determined using Fisher's formula for proportions (Fisher et al., 1991), $n = z^2pq / d^2$. Using a 90 per cent confidence level ($z = 1.645$), a population proportion of 0.5 ($p = 0.5$), its complement of 0.5 ($q = 0.5$), and a 10 per cent margin of error ($d = 0.10$), the calculated sample size was $n = (1.645^2 \times 0.5 \times 0.5) / (0.10)^2 = 67.65$, or approximately 67 respondents per group, which is the number targeted for each of the student and teacher samples (rounding up would give 68, a negligible difference). The 90 per cent confidence level and 10 per cent margin of error were adopted to keep the respondent sample feasible given the available time, financial resources, and practical challenges of accessing eligible students and STEM teachers across the sampled schools. A conventional 95 per cent confidence level and 5 per cent margin of error would require approximately 384 respondents under the same assumptions, which was beyond the study's feasible scope. The school and respondent sample sizes were calculated separately because they involved different populations and sampling considerations. Within the sampled schools, Grade 10 and 11 students and STEM teachers were selected through simple random sampling, giving each eligible participant an equal chance of selection. In addition, one head teacher or assistant head teacher from each sampled school, giving a total of 16 administrators, was purposively selected because of their direct responsibility for curriculum implementation.

Of the 150 questionnaires administered, 132 were returned, representing an overall response rate of 88.0 per cent. Response rates varied across the three respondent groups. Among the 67 targeted students, 57

returned completed questionnaires, yielding a response rate of 85.1 per cent. Of the 67 targeted STEM teachers, 61 returned questionnaires, representing a response rate of 91.0 per cent. Similarly, 14 of the 16 targeted school leaders returned questionnaires, resulting in a response rate of 87.5 per cent. STEM teachers recorded the highest response rate (91.0%), followed by school leaders (87.5%) and students (85.1%). Reporting response rates separately provides a clearer account of participation and data-collection outcomes for each respondent group.

Three structured questionnaires (student, teacher, and head teacher) collected demographic information and responses to Likert-scale items measuring the study variables. All variables included in the inferential analysis were measured using the student questionnaire. STEM performance was measured using four items, while each predictor construct was measured using a four-item scale. The predictor constructs comprised teacher-related factors, school-related factors, student-related factors, and instructional strategies. School-related factors covered resourcing, class-size management, professional development, and leadership support. Scale scores were calculated as the mean item score for each construct. Each construct was operationalised as follows: teacher-related factors captured teachers' inquiry expertise, confidence, and training; student-related factors captured prior knowledge, motivation, and engagement; instructional strategies captured guided and interactive teaching approaches; and school-related factors captured resourcing, class-size management, professional development, and leadership support. STEM performance is a student-reported measure. All items were rated on a Likert scale, and higher scores indicate higher levels of the construct.

The instruments were pretested with 21 respondents in four schools excluded from the main study. Internal consistency was assessed using Cronbach's alpha, with a coefficient of .70 or higher considered acceptable (Nunnally & Bernstein, 1994). The pilot-study coefficients were .794 for STEM performance, .827 for teacher-related factors, 806 for school-related factors, .817 for student-related factors, and .858 for instructional strategies. In the main study, the corresponding Cronbach's alpha coefficients were .810, .835, .831, .810, and .778, respectively. All coefficients exceeded the .70 threshold, indicating acceptable internal consistency for the five scales. Content validity was assessed by four experts who reviewed the questionnaire items for relevance, clarity, and coverage of the respective constructs. The content validity index (CVI) was .75, below the .78 (item-level) and .90 (scale-level) values recommended by Polit and Beck (2006). The content validity of the instruments should therefore be treated as a limitation of the study.

Data were analysed using the Statistical Package for the Social Sciences (SPSS), version 25. Descriptive statistics were used to summarise responses from students, STEM teachers, and school leaders. Pearson's product–moment correlation analysis was conducted to examine the relationships between the study variables. Multiple linear regression was also used to assess the relationship between the four predictor variables and STEM performance. The inferential analyses were based on student-level data (N = 57), because students provided measurements for both the predictor and outcome variables. Accordingly, the five scale scores included in the correlation and regression analyses were derived from the student questionnaire. Because each student completed a single questionnaire containing both the predictor and the outcome items, no linking of records across the three respondent groups was needed, and teacher and school-leader responses were not matched to individual students. Responses from STEM teachers and school leaders were analysed descriptively to provide complementary contextual information and were not linked to individual student records.

The multiple regression model included the four predictor variables simultaneously to examine their relationships with STEM performance while controlling for the other predictors. Unstandardized regression coefficients (B) were used to indicate the expected change in STEM performance associated with a one-unit increase in a predictor, holding the other predictors constant. Standardised regression coefficients (β) were used to compare the relative strengths of the relationships between predictors measured on different scales.

Before interpreting the regression results, the relevant regression assumptions were assessed. Linearity was examined to determine whether the relationships between the predictors and STEM performance were approximately linear. Normality was assessed by examining the distribution of the regression residuals, while multicollinearity was evaluated using tolerance values and variance inflation factors (VIFs). A Shapiro–Wilk test indicated no significant departure from normality in the residuals ($W = .979$, $p = .410$). Tolerance values ranged from .771 to .862, and VIF values ranged from 1.161 to 1.297. Since all tolerance values exceeded the recommended minimum of .10 and all VIF values were below 5, there was no evidence of problematic multicollinearity among the independent variables. Because students were drawn from 16 schools, their observations may have been clustered within schools. However, the analyses did not explicitly account for school-level clustering, and this limitation was considered when interpreting the findings.

Of the 67 students targeted, 57 returned questionnaires, resulting in an achieved student sample of 57. The handling of missing item-level responses was based on the completeness of the returned questionnaires and the requirements of each analysis. Where values were missing, cases were excluded listwise from the analysis concerned. The regression degrees of freedom (4, 52) show that all 57 returned student questionnaires entered the model, so no case was lost to missing data.

Ethical Considerations

Ethical approval was obtained from Daystar University's Ethics Review Committee and the National Commission for Science, Technology and Innovation (NACOSTI). The study obtained informed consent from adult participants, while parental consent and learner assent were obtained for minor participants.

4.0 FINDINGS AND DISCUSSION

Head Teachers' Reports of Institutional Provision

The descriptive findings on institutional provision were derived primarily from reports by head teachers and assistant head teachers. These reports provide insights into school-level support for STEM education; however, they represent respondents' perceptions and accounts rather than independently verified institutional records. Consequently, interpret the findings with caution, as they may be influenced by social desirability or positive-response bias.

Among the head teachers and assistant head teachers surveyed, 92.9 per cent (13 of 14) reported that their schools had dedicated STEM laboratories and managed class sizes to support practical activities. The same proportion reported that their schools funded or facilitated teachers' access to professional development in instructional strategies. In contrast, 85.7 per cent (12 of 14) reported that their schools had an annual budget specifically allocated to STEM resources and equipment. These responses suggest that the participating school leaders generally perceived their institutions as providing substantial structural

and financial support for STEM education, although the reported provisions were not independently verified.

Teachers' ratings followed this general pattern of perceived institutional support. Teachers agreed that school leadership supported innovative teaching practices (M = 4.39, SD = 0.76) and that the school culture promoted innovation and collaboration (M = 4.51, SD = 0.67). Similarly, head teachers rated their support for innovation at M = 4.43 (SD = 0.65) and collaboration among STEM teachers at M = 4.57 (SD = 0.65). These ratings indicate favourable perceptions of leadership support and collaborative school cultures among the respondents.

However, the reports suggested comparatively less emphasis on formal institutional expectations for inquiry-based instruction. Specifically, 64.3 per cent (9 of 14) of head teachers and assistant head teachers reported that their schools formally ensured that teachers received training in inquiry-based learning. In comparison, 78.6 per cent (11 of 14) reported requiring inquiry-based activities in lesson plans. Although these proportions indicate that inquiry-based instruction was reportedly encouraged in many schools, they were lower than the proportions reporting the provision of STEM laboratories, class-size management, and professional development funding. This difference may indicate that the reported structural and financial provisions were more widespread than formal requirements for inquiry-based teaching. Nevertheless, this interpretation is based on respondents' accounts and should not be taken as evidence that the reported institutional provisions or practices were independently confirmed.

Relationship between Study Factors and STEM Performance

Pearson correlation analysis revealed that all four study factors had statistically significant positive relationships with performance in STEM subjects. School-related factors showed the strongest association (r = .605, p < .001), followed by teacher-related factors (r = .563, p < .001), student-related factors (r = .541, p < .001), and instructional strategies (r = .461, p < .001). The relationships ranged from moderate to moderately strong. Table 1 presents the correlation results.

Table 1. Correlation between Study Factors and Performance in STEM Subjects (N = 57)

Factor	r	p (2-tailed)
Teacher-related factors	.563**	< .001
School-related factors	.605**	< .001
Instructional strategies	.461**	< .001
Student-related factors	.541**	< .001

*Note. **p < .01 (2-tailed).*

Multiple regression analysis was conducted to examine the relationship between teacher-related factors, school-related factors, student-related factors, instructional strategies, and performance in STEM subjects. The results indicated that the overall regression model was statistically significant (R = .779, R^2 = .607, adjusted R^2 = .577, $F(4, 52)$ = 20.059, p < .001). Collectively, the four predictors explained 60.7 per cent of the variation in STEM performance. The remaining 39.3 per cent was not explained by the four predictors, reflecting unmeasured influences and measurement error.

As presented in Table 2, teacher-related factors had the largest standardized regression coefficient (β = .329, t = 3.469, p = .001), followed by school-related factors (β = .318, t = 3.136, p = .003), instructional strategies (β = .266, t = 2.795, p = .007), and student-related factors (β = .200, t = 2.110, p = .040). All four predictors were statistically significant at the 5 per cent significance level. Teacher-related factors had the largest standardised coefficient, although the difference between teacher-related and school-related factors was relatively small. However, this difference was not formally tested for statistical significance. The 95 per cent confidence intervals for the unstandardized coefficients, calculated from the reported B and SE, were wide and overlapped substantially (teacher-related factors, 0.129 to 0.487; school-related factors, 0.108 to 0.494; student-related factors, 0.009 to 0.391; instructional strategies, 0.073 to 0.447), so the ordering of the predictors should be treated as tentative. The findings suggest that, when the other predictors were held constant, teacher-related and school-related factors had comparatively stronger associations with STEM performance than instructional strategies and student-related factors. Unstandardized coefficients (B) show the expected change in STEM performance for a one-unit increase in a predictor. In contrast, the others are held constant (for example, B = 0.301 for school-related factors). In contrast, standardised coefficients (β) place the predictors on a common scale so that their relative contributions can be compared.

Table 2. Regression Coefficients Predicting Performance in STEM Subjects (N = 57)

Predictor	B	SE	β (standardized)	t	p
Constant	−0.300	0.425		−0.705	.484
Teacher-related factors	0.308	0.089	.329	3.469	.001
School-related factors	0.301	0.096	.318	3.136	.003
Student-related factors	0.200	0.095	.200	2.110	.040
Instructional strategies	0.260	0.093	.266	2.795	.007

Note. Dependent variable: performance in STEM subjects. B = unstandardised regression coefficient; SE = standard error; β = standardised regression coefficient. Model summary: R = .779, R^2 = .607, adjusted R^2 = .577, standard error of the estimate = .37132. ANOVA: F(4, 52) = 20.059, p < .001. The displayed significance value of .000 in SPSS is reported as p < .001.

Substantively, the standardised regression coefficients indicate that school-related factors were associated with STEM performance similarly to teacher-related factors, and had numerically larger standardised coefficients than instructional strategies and student-related factors, when all four predictors were considered simultaneously. However, school-related factors were measured using a composite scale encompassing resource availability, class-size management, and leadership support. Consequently, the analysis does not establish the independent contribution of each component, particularly the distinct roles of leadership support and resource provision. The descriptive findings suggest that teacher capacity may also be influenced by school leadership through professional development opportunities and time allocated for collaborative planning. However, the regression analysis did not directly test this interpretation, so the Discussion section explores it further.

Discussion

The findings indicate that school-related factors were positively associated with STEM performance (r = .605, p < .001) and had the second-largest standardised regression coefficient (β = .318, p = .003). This

coefficient was close to that of teacher-related factors (β = .329, p = .001) and larger than those of instructional strategies (β = .266, p = .007) and student-related factors (β = .200, p = .040). Earlier studies have examined leadership primarily as a conceptual, qualitative, or indirect influence (Heck & Hallinger, 2014; Mupa, 2023; Riddel & Zulfikar, 2024). The present findings add quantitative estimates of the relative associations between these factors and STEM performance within a single regression model. The size of the school-related coefficient broadly supports the view that school-level conditions matter for learning (Hallinger & Heck, 1998; Louis et al., 2010), although those studies modelled indirect leadership effects in other settings and are not directly comparable. However, they do not establish that leadership causes improved performance or mediates the relationships between teacher-related, student-related, or instructional factors and performance outcomes. The cross-sectional design limits causal interpretation, and the school-related scale incorporates resourcing alongside other school conditions.

The descriptive findings reveal a gap between resource provision and the formal institutionalisation of inquiry-based learning (IBL). More than 90 per cent of head teachers reported having laboratories, managing class size, and providing funding for professional development, whereas 64.3 per cent reported formally ensuring IBL training and 78.6 per cent reported requiring inquiry-based activities in lesson plans. These figures represent head teachers' self-reports and were not directly linked to student performance in the analysis. One possible interpretation is that institutionalising IBL through formal expectations may be less established than providing the resources needed to support STEM teaching. Further research involving more schools and independently verified school-level data could examine this possibility.

The findings can also be considered in relation to the literature on educational resourcing. Doboyou and Nyamu (2023) and Gómez and Suárez (2020) investigated attitudes and achievement in different contexts, including secondary schools in Kiambu County, Kenya, and a national PISA sample from Colombia, respectively. International schools in Nairobi may have different resource profiles, and head teachers in the present study reported high levels of laboratory provision and class-size management. Nevertheless, resource availability was not independently measured in the student-level data, and the school-related scale included resourcing. Consequently, the analysis cannot establish whether school-related factors remain associated with STEM performance after controlling for resource availability. One possible explanation is that school conditions may be associated with performance not only through infrastructure but also through leadership practices that support experimentation, collaborative planning, and the formal integration of inquiry-based learning into school policy. This interpretation is consistent with Wooley's (2025) identification of competencies specific to STEM leadership, but it remains a hypothesis that requires further empirical testing.

Teacher-related factors had the largest standardised regression coefficient (β = .329, p = .001). Although these findings suggest that teacher-related factors were comparatively strongly associated with STEM performance, the analysis does not establish how school leadership may relate to teacher capacity. One possible interpretation is that leadership practices may support teacher capacity through professional development funding, protected time for collaborative planning, and expectations for inquiry-based lesson design. Improved teacher capacity may, in turn, be associated with better student outcomes. However, this proposed pathway was not tested in the present study. Future research could examine it using mediation analysis supported by longitudinal or multilevel data.

Student-related factors (β = .200, p = .040) and instructional strategies (β = .266, p = .007) also had statistically significant positive associations with STEM performance. However, their standardised coefficients were smaller than those of teacher-related and school-related factors. These findings are compatible with research reporting higher engagement and performance in STEM-focused schools (Ghawas et al., 2025) and with the argument that guided inquiry can be effective when combined with direct instruction (De Jong et al., 2023). Nevertheless, the relative sizes of the regression coefficients should be interpreted cautiously. They do not establish that instructional strategies or student-related factors are inherently less important; rather, they indicate their relative associations with STEM performance when all four predictors are considered simultaneously. The findings therefore highlight the relevance of teacher-related and school-related conditions while recognising that student-related factors and instructional strategies also contribute to understanding variation in STEM performance.

Limitations of the Study

The cross-sectional design and the reliance on self-reported perception data limit causal inference. STEM performance itself was a four-item, student-reported measure rather than examination results or school records, so it may not reflect actual attainment. The association between leadership-related conditions and STEM performance cannot rule out reverse or reciprocal influence; for example, schools that already achieve strong STEM outcomes may be better placed to invest in leadership capacity. Predictors and the outcome came from the same student respondents, which may inflate associations through common-method bias, and head teachers' reports may reflect social desirability. The school-related scale combines resourcing, class-size management, and leadership support, so leadership cannot be separated from resources, and resource levels were not measured independently. Content validity was also weak (CVI = .75, below the recommended thresholds), so some items may not fully represent their constructs. Students were nested in 16 schools, and a single-level regression does not account for clustering. Diagnostics for linearity, homoscedasticity, and influential cases are not reported, so the regression estimates should be read with that caveat.

The school sample was calculated with a wide (20%) margin of error and the final student sample was modest (N = 57), which limits precision and statistical power. The confidence intervals around the individual coefficients are wide, so the predictor ranking is tentative. The sample was confined to international schools in one county, a relatively well-resourced context, which limits generalizability to Kenya's public and lower-resourced private schools and to schools that implement the CBC. Finally, the teacher and head-teacher data are descriptive and were not linked to individual student outcomes. They strengthen confidence in the direction of the relationships but do not substitute for a larger, multi-source, multilevel model.

5.0 CONCLUSION AND RECOMMENDATIONS

Conclusion: The study concluded that school-related factors were positively associated with STEM performance among international schools in Nairobi, suggesting that leadership and institutional capacity may support inquiry-based STEM learning; however, the findings are limited to this context and do not establish mediation or generalizability to Kenya's wider school system.

Recommendations: The study recommends that, first, school leaders should embed inquiry-based practice in lesson-planning requirements, supervision routines, and performance appraisal. Head teachers reported near-universal provision of infrastructure but lower rates of formal requirements for inquiry-

based lessons (78.6%) and training (64.3%). Second, leaders should treat protected time for peer observation and collaborative lesson planning as a core resourcing decision. Third, leaders should not assume that learner motivation alone will carry inquiry-based reform. Student-related factors were also significantly associated with STEM performance, so schools should monitor how well students with weaker prior STEM knowledge are supported. Fourth, because teacher-related factors had the largest standardised coefficient, leaders should sustain targeted, continuous professional development in inquiry-based pedagogy and STEM assessment, and ensure that laboratory facilities and teaching materials are available and used.

Additionally, policy bodies concerned with scaling inquiry-based STEM instruction under Kenya's Competency-Based Curriculum should consider including instructional leadership in head-teacher preparation and appraisal, alongside teacher training. This is a recommendation to evaluate, not a proven remedy. The findings come from international schools that do not implement the CBC, and they show an association, not an effect. Assessment bodies, including the Kenya National Examinations Council, could also consider assessment frameworks that credit inquiry, process, and applied reasoning, since assessment design is among the levers that shape what school leaders and teachers prioritise.

Ultimately, future studies should use multilevel models that account for students nested in schools, with larger samples. They should measure leadership separately from resources, use objective performance data alongside self-reports, and test mediation through teacher capacity with longitudinal designs. Replication in public schools, lower-resourced private schools, and schools that implement the CBC would show whether the associations hold. Qualitative follow-up with head teachers and teachers would help explain how leadership practices are experienced in classrooms.

6.0 REFERENCES

1. Adams, D., & Hamdhiyya. (2022). Leadership in science instruction: A systematic review of research. *Asia Pacific Journal of Educators and Education, 37*(2), 247–261. https://doi.org/10.21315/apjee2022.37.2.12
2. Anthony, H. M., Ndubuisi, S. A., & Ehigie, D. E. (2021). Integrating active learning and inquiry-based approaches to enhance student engagement and achievement in STEM classrooms. *Journal of Advances in Education and Philosophy, 5*(12), 429–439. https://doi.org/10.36348/jaep.2021.v05i12.009
3. Chu, S. K. W., Reynolds, R. B., Tavares, N. J., Notari, M., & Lee, C. W. Y. (2017). *21st century skills development through inquiry-based learning: From theory to practice*. Springer. https://doi.org/10.1007/978-981-10-2481-8
4. Cunningham, N. (2024). *Grade 6 mathematics teachers' use of inquiry-based learning as a pedagogical tool* [Master's dissertation, University of Pretoria]. University of Pretoria Repository. http://hdl.handle.net/2263/100044
5. De Jong, T., Lazonder, A. W., Chinn, C. A., Fischer, F., Gobert, J., Hmelo-Silver, C. E., Koedinger, K. R., Krajcik, J. S., Kyza, E. A., Linn, M. C., Pedaste, M., Scheiter, K., & Zacharia, Z. C. (2023). Let's talk evidence: The case for combining inquiry-based and direct instruction. *Educational Research Review, 39*, Article 100536. https://doi.org/10.1016/j.edurev.2023.100536
6. Dewey, J. (1938). *Experience and education*. Macmillan. https://openlibrary.org/books/OL6367993M/Experience_and_education

7. Doboyou, J. T., & Nyamu, F. K. (2023). Utilization of inquiry-based approach and its influence on students' attitudes towards biology in secondary schools in Kiambu County, Kenya. *International Journal of Research and Innovation in Social Science, 7*(10), 6–15. https://doi.org/10.47772/IJRISS.2023.701002
8. Fisher, A. A., Laing, J. E., Stoeckel, J. E., & Townsend, J. W. (1991). *Handbook for family planning operations research design* (2nd ed.). Population Council. https://knowledgecommons.popcouncil.org/departments_sbsr-rh/980
9. Gatama, S. N., Otieno, M. A., & Waweru, S. N. (2023). Principals' instructional leadership and its influence on students' academic achievement in public secondary schools in Nyeri and Nyandarua Counties in Kenya. *East African Journal of Education Studies, 6*(1), 148–163. https://doi.org/10.37284/eajes.6.1.1080
10. Ghawas, S. A., Munir, F., & Khalid, L. (2025). Students' engagement and their academic performance in STEM and non-STEM elementary schools. *Social Sciences Spectrum, 4*(2), 199–217. https://doi.org/10.71085/sss.04.02.264
11. Gómez, R. L., & Suárez, A. M. (2020). Do inquiry-based teaching and school climate influence science achievement and critical thinking? Evidence from PISA 2015. *International Journal of STEM Education, 7*, Article 43. https://doi.org/10.1186/s40594-020-00240-5
12. Hallinger, P., & Heck, R. H. (1998). Exploring the principal's contribution to school effectiveness: 1980–1995. *School Effectiveness and School Improvement, 9*(2), 157–191. https://doi.org/10.1080/0924345980090203
13. Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge. https://doi.org/10.4324/9780203887332
14. Heck, R. H., & Hallinger, P. (2009). Assessing the contribution of distributed leadership to school improvement and growth in math achievement. *American Educational Research Journal, 46*(3), 659–689. https://doi.org/10.3102/0002831209340042
15. Heck, R. H., & Hallinger, P. (2014). Modeling the longitudinal effects of school leadership on teaching and learning. *Journal of Educational Administration, 52*(5), 653–681. https://doi.org/10.1108/JEA-08-2013-0097
16. Kenya Institute of Curriculum Development. (2017). *Basic education curriculum framework: Nurturing every learner's potential*. https://kicd.ac.ke/wp-content/uploads/2018/03/CURRICULUM-FRAMEWORK-FINAL-2017.pdf
17. Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice-Hall. https://search.worldcat.org/title/9555621
18. Kunalan, A., Cheah, P. K., Moses, P., Er, P. H., & Ng, C. A. (2018). Teaching strategies employed by academics in STEM education: A qualitative inquiry. *E3S Web of Conferences, 65*, Article 04002. https://doi.org/10.1051/e3sconf/20186504002
19. Kunga, J. G., Embeywa, H., & Koech, P. K. (2022). The effects of inquiry-based science teaching approach on task competence of secondary school Physics students in Kitui County, Kenya. *Machakos University Journal of Science and Technology, 3*, 1–11. http://ir.mksu.ac.ke/handle/123456780/12587
20. Louis, K. S., Leithwood, K., Wahlstrom, K. L., & Anderson, S. E. (2010). *Investigating the links to improved student learning: Final report of research findings*. University of Minnesota, Center for Applied Research and Educational Improvement. https://hdl.handle.net/11299/140885

21. Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: A systematic literature review. *International Journal of STEM Education, 6*, Article 2. https://doi.org/10.1186/s40594-018-0151-2

22. Mupa, P. (2023). School leadership and its dexterity to provide access to quality instruction: A case of a private academy in Masvingo, Zimbabwe. *African Perspectives of Research in Teaching & Learning, 6*(2), 59–78. http://hdl.handle.net/10386/4391

23. Nghiem, X. H., Yadav, R., Yadav, M., Dewasiri, N. J., & Ranasinghe, A. (2025). Project-based learning and inquiry-based learning. In M. Wilkins (Ed.), *Exploration of K-12 teaching and learning for teacher educators* (pp. 231–260). IGI Global. https://doi.org/10.4018/979-8-3693-9370-3.ch009

24. Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill. https://search.worldcat.org/title/28221417

25. Nzomo, C. M., Rugano, P., Njoroge, J. M., & Gitonga, C. M. (2023). Inquiry-based learning and students' self-efficacy in Chemistry among secondary schools in Kenya. *Heliyon, 9*(1), Article e12672. https://doi.org/10.1016/j.heliyon.2022.e12672

26. Piaget, J. (1980). The psychogenesis of knowledge and its epistemological significance. In M. Piattelli-Palmarini (Ed.), *Language and learning: The debate between Jean Piaget and Noam Chomsky* (pp. 23–34). Harvard University Press. https://search.library.wisc.edu/catalog/999512195602121

27. Polit, D. F., & Beck, C. T. (2006). The content validity index: Are you sure you know what's being reported? Critique and recommendations. *Research in Nursing & Health, 29*(5), 489–497. https://doi.org/10.1002/nur.20147

28. Riddel, M., & Zulfikar, I. R. (2024). The role of innovative leadership in transforming student learning effectiveness: A review of best practices and future directions. *Development: Studies in Educational Management and Leadership, 3*(1), 35–50. https://doi.org/10.47766/development.v3i1.1913

29. Roslan, A. N., Phang, F. A., Pusppanathan, J., & Nawi, N. D. (2023). Challenges in implementing inquiry-based learning (IBL) in physics classroom. *AIP Conference Proceedings, 2569*, Article 050010. https://doi.org/10.1063/5.0117509

30. Sichangi, M. N. (2024). *Effect of inquiry-based learning on mathematics learning achievement in STEM-integrated secondary schools in Kenya* [Doctoral dissertation, University of Nairobi]. University of Nairobi Digital Repository. http://erepository.uonbi.ac.ke/handle/11295/166854

31. Tan, C. Y., Liu, P., & Wong, W. L. V. (2020). Different patterns of relationships between principal leadership and 15-year-old students' science learning: How school resources, teacher quality, and school socioeconomic status make a difference. *Frontiers in Psychology, 11*, Article 2257. https://doi.org/10.3389/fpsyg.2020.02257

32. Twahirwa, J. N., Ntivuguruzwa, C., Twizeyimana, E., & Nyirahagenimana, J. (2022). Teachers' perceptions of inquiry-based learning in science education: A case of selected secondary schools in Kirehe District, Rwanda. *East African Journal of Education and Social Sciences, 3*(3), 29–38. https://doi.org/10.4314/eajess.v3i3.176

33. Vygotsky, L. S. (1962). *Thought and language* (E. Hanfmann & G. Vakar, Eds. & Trans.). MIT Press. (Original work published 1934). https://opac.lib.kit.ac.jp/opac/opac_link/bibid/TY10004987

34. Wooley, M. A. (2025). *Competencies for effective STEM leadership: Essential knowledge, skills, dispositions, and practices to inform STEM education programs and support program leadership* [Doctoral dissertation, Louisiana Tech University]. Louisiana Tech Digital Commons. https://digitalcommons.latech.edu/dissertations/1045

35. Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.). Harper & Row. https://librarycatalog.ecu.edu/catalog/13495