International Journal of Educational Management and Development Studies
Volume 7 Issue 2 June 2026
DOI: https://doi.org/10.53378/ijemds.353361

Institutional management strategies and upscaling of digital literacy programmes in public primary schools: The moderating role of school leadership quality

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Abstract

The Kenyan education system is going through a radical change with the implementation of the Competency Based Curriculum (CBC) and the Digital Literacy Programme (DLP). Full DLP integration has yet to be realised in majority of public primary schools even after government distribution of digital devices, especially in Elgeyo Marakwet County where about 69.3% of the schools have not done so. This study investigates the effect of staff training and provision of digital literacy resources on the upscaling of the DLP in public primary schools in Elgeyo Marakwet County, Kenya and explores how the quality of leadership moderated these relationships. Concurrent triangulation design, a blend of quantitative and qualitative, was adopted. Public primary schools (n = 345) were the target population with a total of 120,929 eligible respondents. A random sample of 28 Head Teachers, 28 BOM Chairpersons, 307 Teachers and 384 Learners with four QASOs being purposely sampled. Thematic analysis was conducted for qualitative data and descriptive statistics and inferential statistics (SPSS. v.23) were used for quantitative data. The findings showed that the staff training (β =0.378; $p < 0.05$) and the provision of the DLP resources (β =0.595; $p < 0.001$) were important when upscaling DLP. Importantly, both relationships were significantly mediated by the quality of school leadership: Training × Leadership (β = 0.218; = 0.001) and Resources × Leadership (β = 0.267; = 0.000) with the complete model explaining 81.2% of the variance of DLP upscaling (R 2 = 0.812). Investments in teacher professional development, digital infrastructure, and school leadership development are critical for meaningful DLP upscaling in resource constrained public primary schools and need to be done strategically and persistently.

Keywords: *staff training, ICT resource provision, DLP upscaling, Elgeyo Marakwet*

Article History:

***Received**: March 25, 2026* ***Revised**: May 19, 2026*
***Accepted**: June 2, 2026* ***Published online**: June 9, 2026*

Suggested Citation:
Titus, B.K., Ochieng, P. & Gikandi, J.W. (2026). Institutional management strategies and upscaling of digital literacy programmes in public primary schools: The moderating role of school leadership quality. *International Journal of Educational Management and Development Studies*, 7(2), 126-147. https://doi.org/10.53378/ijemds.353361

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1. Introduction

There have been far reaching reforms in recent years to the education system in Kenya with the phased implementation of Competency-Based Curriculum (CBC) in 2017 and the national roll-out of the Digital Literacy Programme (DLP) in the primary schools of the country in 2017. The DLP is a program that has been adopted as part of the Vision 2030 agenda in Kenya and is supposed to inculcate the use of digital devices such as tablets, internet enabled devices and educational software into the teaching and learning process (Ministry of Education, 2020) of digital technologies into primary school has been acknowledged as one of the levers which might lead to the improvement of the learning outcomes, the increase of the access to educational resources as well as the preparation of learners to work in the knowledge-based economy (Falloon, 2020; Bejaković & Mrnjavac, 2020). Although the government has made digital devices available to people, an eloquence of DLP implementation, particularly to people in the resource-strapped and rural counties, is evident.

In the Elgeyo Marakwet County, 69.3 out of the total 100 primary schools that were operated by the public had not completely integrated DLP, as of 2022 (MoE, 2022). Out of the 405 primary schools on offer in the county, only 200 of them possessed digital learning devices, as of 2019 (Elgeyo Marakwet County Government, 2019) and the large percentage of the teachers reports that they were of low confidence and low competence levels when using ICT (Kiilu et al., 2022). The institutionalized infractions could be called institutionalized management black holes, especially in the way the schools would then go ahead and operationalize staff training and provision of resources. Although widely accepted, institutional management strategies, such as staff training and provision of resources (Cetindamar Kozanoglu & Abedin, 2021; Avidov-Ungar et al., 2022) are the most significant for the successful implementation of technology in schools, but they do not necessarily apply to school contexts. It is also becoming apparent that the quality of the school leadership, specifically the head teacher in leading the pack in relation to the implementation of technology, professional development, strategic resource allocation and monitoring the process of DLP implementation (Leithwood et al., 2020; Yurtseven Avci et al., 2020). In schools that have sufficient training and resources, leadership can either hinder or enhance the implementation of DLP and the impact of both factors. Thus, this study focused on the effect of staff training and provision of DLRs on the upscaling of DLP in public primary schools of Elgeyo Marakwet County and the moderating effect of school leadership quality on the

relationship between the two. The results offer tangible information for policy makers, school leaders, NGOs and education development partners on how to best tailor the implementation of DLP in a resource-limited environment.

The lack of adoption of DLP in the Elgeyo Marakwet County despite the government's policy commitments and distribution of DLP by the government is indicative of the institutional management shortcomings. There is ample literature from Sub Saharan Africa and in the case of Kenya that lack of ICT infrastructure and teacher's unpreparedness are the main challenges facing scale up of digital education (Agyei, 2021; Morara et al., 2020; Okello et al., 2020). However, most of the previous studies have focused on the impact of staff training and the availability of resources as independent predictors of DLP integration, and they have not investigated boundary conditions for integration that are successful or unsuccessful. The leadership of primary schools in Kenya is a context sensitive variable which has not been empirically studied. This research paper was able to fill such a twofold gap.

Specifically, this paper aims to prove the following research hypotheses:

H_{01}: Training of staff has no significant influence on the upscaling of digital literacy programmes in public primary schools in Elgeyo Marakwet County.

H_{02}: Provision of digital literacy resources has no significant influence on the upscaling of digital literacy programmes in public primary schools in Elgeyo Marakwet County.

H_{03}: School leadership quality does not significantly moderate the relationship between staff training, provision of digital literacy resources, and DLP upscaling in public primary schools in Elgeyo Marakwet County.

2. Literature Review

2.1. Theoretical Framework

Administrative management theory. This paper is based on the theory called Administrative Management Theory developed by Henri Fayol in early 20th Century. Fayol formulates 14 principles of management, which when applied together will provide a model on how an organization can be efficient and attain its goals. With respect to the application of this theory to education, it is worth highlighting the role of the education institution's leadership, the planning of the institution itself and the institutionalization of the hierarchical organization of resources in determining the capacity of an institution for programmatic innovations like the DLP (Brunetti et al., 2020). More importantly, the aspect of unity of

command, by Fayol, puts the head teacher at the Centre of decision making and coordinating the implementation of decisions. Administrative Management Theory therefore not only serves as an independent variable in this study (staff training and provision of resources), but it also serves as a moderating variable, the action of which is to plan, guide and maintain the process of DLP implementation (in the sense of school leadership quality).

Technology Acceptance Model. The suggested model is an alternate perspective that the Technology Acceptance Model (TAM) suggested by Davis (1989) provides. The theoretical background of TAM is that perceived usefulness and perceived ease of use will affect teachers' behavioral intentions to use the technology. Perceived ease of access and ease of use is the determinant according to this study (Alamri et al., 2021), which is resource provision. TAM is included as the determinant of perceived ease of access and use as well as the determinant of perceived competence and confidence among teachers in provision of resources in this study (Alamri et al., 2021). The quality of leadership in schools can be considered a contextual moderator of TAM: a school leader who is proactive in supporting the use of technology, is a mentor, and contributes to a positive school culture can support the perception of teacher of the usefulness and usability of digital tools, and help crystallize the training-uptake and resource-uptake routes through which TAM translation into DLP integration takes place.

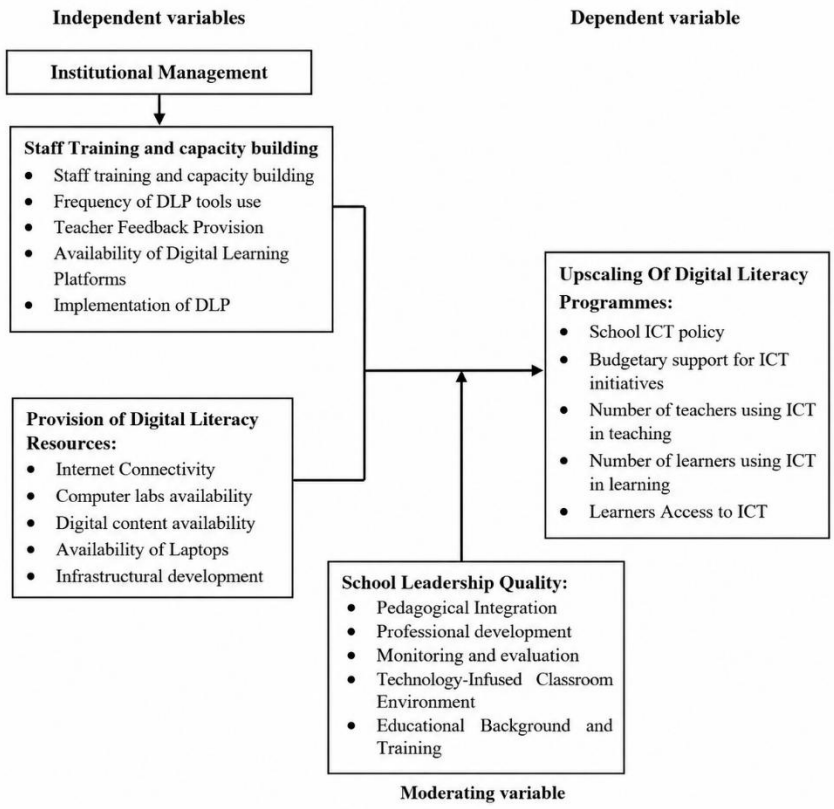
Instructional leadership theory. The Instructional Leadership Theory, which was advanced by Hallinger and Heck (1998) and developed by Leithwood et al. (2020) are based on the premise that school leaders can directly and indirectly influence the learning outcomes of the learners by creating conditions of organization of instructions. Instructional leaders who establish technology vision that is visible, staff capacity building, management of the instructional programme, and fostering positive school learning climate are enabling factors in the digital education environment that optimally translate staff training and resources provision into upscaling DLP. The moderating role of the quality of school leadership that will buffer the impact of the same training programme or resource package on the impact of the DLP is explicitly supported by this theory.

2.2. Conceptual Framework

The conceptual framework of this study consists of staff training (X_1), provision of digital literacy resources (X_2), and school leadership quality as independent variables that influence the dependent variable, DLP upscaling (Y). School leadership quality (M) also serves as a moderating variable in the relationship between the independent variables and DLP upscaling.

Figure 1

Conceptual framework



Staff training includes official ICT training, capacity-building programmes, continuous professional development, and feedback provision. The provision of digital literacy resources encompasses hardware, software, internet connectivity, and digital learning resources. DLP upscaling is operationalized through the extent to which digital tools are integrated into curriculum delivery, classroom instruction, and interactions with learners.

School leadership quality includes the promotion of DLP, teacher development, resource allocation, setting expectations for DLP implementation, and monitoring and evaluating DLP implementation. The moderating model assumes that the relationships between staff training and DLP upscaling (X_1–Y) and between the provision of digital literacy

resources and DLP upscaling (X_2–Y) are not constant but vary according to the quality of school leadership (M). Thus, school leadership quality influences DLP upscaling by modifying the strength of these relationships in a multiplicative manner.

2.3. Staff Training and Upscaling of Digital Literacy Programmes

The adoption of digital programmes has long been an integral component of institutional management and has consistently attracted attention in the literature. Based on the literature, Rafi et al. (2019) identified several key areas of digital skills training, including the use of digital tools, the integration of ICT into teaching, the assessment of digital skills, and the promotion of digital equity. Similarly, Brunetti et al. (2020), in a study conducted in Pakistan, demonstrated that technical training is a strong intervention for enhancing staff capacity to implement DLP. Morara et al. (2020) also found that schools in which management actively encouraged teacher training as a managerial strategy experienced more effective DLP development. These findings are consistent with outcomes reported in Kenya.

Macharia (2022) argues that continuous professional development in Kenyan primary schools leads to measurable benefits in the integration of DLPs. Likewise, Kiilu et al. (2022) found that teachers' ICT self-confidence, a strong predictor of digital tool adoption, is largely influenced by training. Omboto et al. (2022) further emphasized the importance of continuous learning cycles in sustaining programme growth in Uganda. However, Tondeur et al. (2017) demonstrated that training programmes focused solely on technical skills, without considering pedagogical integration, are less effective in under-resourced settings. Similarly, Alvarez (2021) warned that unbalanced training initiatives may contribute to digital inequalities between urban and rural areas. Furthermore, the level of active support and participation provided by school administration in professional development programmes is important in moderating the impact of training. This perspective supports the moderation hypothesis underlying the theoretical framework of the present study.

2.4. Provision of Digital Literacy Resources and Upscaling of DLP

Digital infrastructure, including hardware, software, internet connectivity, and educational content, is a prerequisite for the successful upscaling of DLPs. Wambua et al. (2023) concluded that investment in comprehensive digital resources helps develop the competencies learners require to participate effectively in the digital economy. Similarly,

Brouwer and Groenewegen (2021) validated that the perceived availability and appropriateness of hardware and software are directly associated with DLP adoption. Anthonysamy et al. (2020) further revealed that learner outcomes improve significantly when digital environments are consistently provided and adequately supported.

In Kenya, Onsomu et al. (2022) argued that the mobilization of physical infrastructure is the foundational step toward meaningful DLP expansion. However, the high cost of hardware and internet connectivity continues to constrain implementation in many public primary schools in Elgeyo Marakwet County (MoE, 2020). Duma et al. (2021) reported that the use of instructional technology is often limited by inadequate equipment, outdated devices requiring replacement, and unreliable electricity supply in rural African school settings. Bergson-Shilcock (2020) described the paradox of resources without capacity, whereby resources are provided but remain underutilized. Likewise, Selwyn (2021) cautioned that the provision of resources alone is insufficient without addressing broader structural challenges within the education system. These perspectives suggest that the effects of resource provision are influenced by contextual conditions, thereby supporting the moderating factor examined in this study and providing a basis for the moderation analysis.

2.5. School Leadership Quality as a Moderating Variable

School leadership has been demonstrated to be a key contextual factor in studies of educational technology integration. Leithwood et al. (2020) identified several organizational factors associated with effective instructional leadership, including a clear vision, support for professional development, effective resource management, and a culture of continuous improvement. These factors were found to contribute positively to successful technology integration outcomes. Similarly, Yurtseven Avci et al. (2020) empirically demonstrated that the relationship between ICT training investments and classroom technology use was significantly stronger in schools where principals were highly supportive. Leadership functions as a moderator rather than merely a predictor of technology integration.

In Sub-Saharan Africa, Alanoglu et al. (2022) found that school administrators' digital literacy philosophies moderated the relationship between teacher professional development and actual ICT adoption. Likewise, Avidov-Ungar et al. (2022) identified different typologies of digital leadership roles that either facilitate or constrain technology integration, with the most promising adoption outcomes associated with innovation-enabling leadership. Kiilu et al.

(2022) further reported that schools in which head teachers personally monitored and evaluated DLP integration exhibited higher levels of DLP implementation among teachers. Therefore, the quality of school leadership moderates the effects of both staff training and resource provision on the upscaling of DLP.

3. Methodology

3.1. Research Design

The research employed a concurrent triangulation design (convergent parallel model) as proposed by Creswell (2014), in which quantitative and qualitative data were collected simultaneously, analyzed separately, and subsequently integrated during the interpretation stage. This design facilitated comprehensive triangulation by combining numerical patterns derived from quantitative data with contextual insights obtained from institutional stakeholders. The quantitative strand utilized hierarchical moderated multiple regression analysis to test the moderation hypotheses, following the classical moderation model operationalized by Hayes (2018) through the PROCESS Macro.

3.2. Study Area

The study was conducted in publicly funded primary schools in Elgeyo Marakwet County, located in the Rift Valley region of Kenya. The county has an estimated population of approximately 454,480, with 74.9% of residents living below the poverty line (Kenya National Bureau of Statistics, 2019). The county comprises four sub-counties, Keiyo North, Keiyo South, Marakwet East, and Marakwet West, which differ in terms of resource endowment and leadership contexts, making the area an appropriate setting for examining moderating effects. As of 2022, digital devices had been deployed in only 200 of the 405 public primary schools, and among these schools, only 69.3% had fully integrated DLP into their educational practices (MoE, 2022).

3.3. Target Population and Sampling

A total of 4,120 respondents (Table 1) were targeted from 345 public primary schools. The sample size of head teachers and teachers was determined using Yamane's formula and the sample size came out to be 28 head teachers and 307 teachers for the four sub-counties. To ensure geographical representativeness, stratified random sampling was used to

proportionately select participants from all four sub-counties. Purposive sampling was used for the selection of Quality Assurance and Standards Officers (QASOs). Table 2 shows the final distribution of the sample in the four sub-counties.

Table 1

Target population of the study

Category of Respondents	Target Population
Head Teachers	345
Teachers	3,771
QASOs	4
Total	**4,120**

Source: Elgeyo Marakwet County Education Office (2023)

Table 2

Sample distribution by sub-county

Sub-County	Head Teachers	Teachers
Keiyo North	7	77
Keiyo South	7	77
Marakwet East	7	77
Marakwet West	7	76
Total	**28**	**307**

Source: Field Data (2024)

The questionnaires and interview schedules were distributed and administered between September and November 2024 to a target population of 339 participants. A total of 260 responses were collected, resulting in an overall response rate of 77%. The response rates by participant category were as follows: head teachers, 22 out of 28 (80%); teachers, 234 out of 307 (76%); and QASOs, 4 out of 4 (100%). The overall response rate exceeded the 50% threshold recommended by Mugenda (2008).

For the quantitative analysis, data from the 234 teacher respondents were utilized, while data obtained from interviews with head teachers and QASOs were used for the qualitative analysis. The teachers included in the quantitative analysis comprised 234 respondents, of whom 47% were male and 53% were female, reflecting a gender distribution similar to that of Kenya's primary education sector. Regarding educational qualifications, 61% held a Primary Teacher Education (P1) diploma, 27% possessed a bachelor's degree, and 12% had

postgraduate qualifications. Among the 22 head teachers who participated in the study, 80% held either a bachelor's degree or a postgraduate qualification, and 73% had participated in at least one ICT-related training programme during the previous 24 months. These characteristics are representative of the professional profile of primary school teachers in Kenya.

3.4. Research Instruments

Two instruments were used to collect data. The teacher questionnaire was designed as a structured survey utilizing a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The questionnaire gathered information on staff training, the availability of digital resources, and the quality of school leadership. Structured interview guides were also developed and administered to head teachers and QASOs.

A validated five-item scale adapted from the Instructional Leadership Inventory developed by Hallinger and Murphy (1985) was used to assess the quality of school leadership. The scale measured key dimensions of instructional leadership, including advocacy for the Digital Literacy Programme (DLP), facilitation of professional development, resource allocation, communication, and monitoring and evaluation.

Content validity was established through expert review by two professors in the field. The instruments were subsequently pilot-tested in five schools that were not included in the main study sample. Reliability was assessed using Cronbach's alpha, and the results indicated that all scales exceeded the recommended threshold of 0.70 (Mugenda, 2008). Specifically, the staff training scale yielded a reliability coefficient of $\alpha = .82$, the digital resources scale $\alpha = .79$, and the school leadership scale $\alpha = .86$, demonstrating satisfactory internal consistency.

3.6. Data Analysis

The quantitative data were analyzed using IBM SPSS Statistics Version 23. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were computed for all Likert-scale items. Pearson's correlation analysis was conducted to examine the bivariate relationships among the study variables.

A hierarchical moderated multiple regression analysis was performed in two steps. In Step 1, the main effects of staff training (X_1), provision of digital literacy resources (X_2), and school leadership quality (M) were entered into the model. In Step 2, the interaction terms ($X_1 \times M$ and $X_2 \times M$) were added separately to assess the moderating effect of school leadership

quality. Following the recommendation of Hayes (2018), all continuous variables were mean-centered before creating the interaction terms to reduce the risk of multicollinearity. The regression model used in the analysis was:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 M + \beta_4 (X_1 \times M) + \beta_5 (X_2 \times M) + \varepsilon$$

The moderating effects were assessed in Step 2 through changes in the coefficient of determination (ΔR^2). Prior to conducting the regression analysis, the assumptions of normality, linearity, multicollinearity, and independence of errors were examined. Normality was assessed using the Kolmogorov–Smirnov test, linearity through scatterplot analysis, multicollinearity using Variance Inflation Factor (VIF) values below 10, and independence of errors using the Durbin–Watson statistic, with values close to 2.00 indicating no autocorrelation.

Qualitative data were analyzed using thematic analysis. Prior to data collection, ethical clearance was obtained from the Mount Kenya University Institutional Research Ethics Committee (MKU-IREC). Written informed consent was obtained from all participants, including head teachers, teachers, and QASOs. Participants were informed of their right to withdraw from the study at any time without penalty. Confidentiality was strictly maintained throughout the study, and no personally identifiable information was collected or disclosed. The study was conducted in accordance with the ethical guidelines established by the National Commission for Science, Technology and Innovation (NACOSTI) for research involving human participants.

4. Results

Table 3 presents the descriptive statistics on the influence of staff training on the upscaling of DLP. The findings indicate that training and capacity-building sessions enhanced the digital literacy levels of respondents to a moderate extent (M = 3.69, SD = 1.53), which suggests generally positive perceptions of the training programmes, albeit with considerable variation in responses. A majority of respondents (61.1%) agreed that training had enabled them to integrate ICT tools more frequently into classroom activities (M = 3.61, SD = 1.25). In addition, 51.3% confirmed that constructive feedback mechanisms were incorporated into the training programmes (M = 3.63, SD = 1.65).

Table 3

Staff training and upscaling of digital literacy programmes (n = 234)

Statement	SA%	A%	U%	D%	SD%	Mean	SD
Undergone training/capacity building sessions adequately assessing digital literacy skills	49.6	12.0	11.1	12.8	14.5	3.69	1.53
Training helped to frequently incorporate ICT tools in classroom activities	29.5	31.6	15.4	17.1	6.4	3.61	1.25
Teachers provide constructive feedback on effectiveness of digital literacy training	31.2	20.1	20.5	14.1	14.1	3.63	1.65
Availability of digital learning platforms enhances students' digital literacy skills	30.8	25.2	13.7	16.2	14.1	3.42	1.43
Training has enabled implementation of DLP in the primary school	30.8	25.2	12.8	12.4	18.8	3.37	1.49

Notes: Source: Field Data (2024). Legends: SA = Strongly Agree; A = Agree; U = Undecided; D = Disagree; SD = Strongly Disagree

The relatively high standard deviation values, all exceeding 1.25, indicate substantial variation in respondents' experiences and perceptions, consistent with Tondeur et al. (2017) and Alvarez (2021) on inconsistencies in both the quality and delivery of training across schools and sub-counties. These quantitative findings were further supported by qualitative data from one head teacher, who stated:

> *"The school needs to make sure that the lessons learnt during the training get applied to the classroom and most importantly, teachers need to be empowered with the skills to use the educational technologies."*

The findings presented in Table 4 indicate that internet connectivity to support DLP upscaling was generally inadequate across schools, particularly in Marakwet East and Marakwet West. This was reflected by 64.5% of respondents, with a mean score of 3.74 (SD = 1.28). However, 64.9% of respondents confirmed the availability of adequate digital content (M = 3.63, SD = 1.09). The results also revealed a significant resource deficit, as 59.4% of respondents reported the lack of digital devices and accessories, such as laptops (M = 3.46, SD = 1.33).

The lowest mean score was recorded for the adequacy of overall infrastructure to meet DLP requirements (M = 3.24, SD = 1.32), with only 47.5% of respondents expressing agreement. Findings showed that infrastructural limitations remain a major challenge to the effective implementation and expansion of DLPs.

Table 4

Provision of digital literacy resources and DLP upscaling (n = 234)

Statement	SA%	A%	U%	D%	SD%	Mean	SD
School has internet connectivity to enhance upscaling of DLP	35.9	28.6	17.1	9.8	8.5	3.74	1.28
There is adequate digital content in school improving upscaling of DLP	20.5	44.4	17.9	12.0	5.1	3.63	1.09
Computer labs have been constructed to enhance upscaling of DLP	19.2	34.6	25.2	11.5	9.4	3.43	1.20
Inadequate digital accessories (e.g., laptops) to enhance DLP integration	24.4	35.0	16.2	11.1	13.2	3.46	1.33
Digital literacy infrastructural developments meet the standards of DLP	19.7	27.8	24.8	15.0	18.8	3.24	1.32

Notes: Source: Field Data (2024). Legend: SA = Strongly Agree; A = Agree; U = Undecided; D = Disagree; SD = Strongly Disagree

The quantitative findings were supported by qualitative evidence from one Quality Assurance and Standards Officer (QASO), who stated:

> *"Availability of resources will increase use of technologies in teaching, but the head teacher will need to ensure that the resources are kept in good condition and accessible if they are to be used; otherwise, they will sit idle."*

This observation provides an early indication of the moderating role of school leadership in influencing the effectiveness of resource provision for DLP upscaling.

Table 5 presents the descriptive statistics for the five school leadership quality items administered to teachers (n = 234). The findings indicate that teachers rated head teachers' effectiveness as champions of DLP implementation most highly, with 68.8% expressing agreement, making it the highest-rated leadership dimension. In addition, 63.2% of respondents confirmed that school leaders effectively communicated DLP goals (M = 3.72, SD = 1.28), while 58.6% agreed that leadership facilitated opportunities for digital training (M = 3.59, SD = 1.31).

Lower levels of agreement were observed for resource allocation (56.4%) and monitoring activities (59.0%), suggesting that leadership support was more evident in advocacy and communication than in resource management and systematic evaluation. These findings indicate that while school leaders generally support DLP implementation, challenges remain in ensuring adequate resource allocation and continuous monitoring of programme activities.

Table 5
School leadership quality descriptive statistics (n = 234)

Statement	SA%	A%	U%	D%	SD%	Mean	SD
The head teacher actively champions and supports the implementation of DLP in this school	38.5	30.3	14.1	9.4	7.7	3.83	1.22
School administrators effectively communicate DLP goals and expectations to teachers	34.6	28.6	18.4	10.3	8.1	3.72	1.28
The head teacher facilitates access to digital training opportunities for teachers	31.2	27.4	19.2	12.8	9.4	3.59	1.31
Leadership allocates and monitors budgets specifically for DLP resource acquisition and maintenance	22.6	33.8	20.9	13.2	9.4	3.47	1.27
The head teacher monitors and evaluates the integration of DLP in classroom instruction	27.8	31.2	17.9	13.7	9.4	3.54	1.30

Notes: Source: Field Data (2024). Legend: SA = Strongly Agree; A = Agree; U = Undecided; D = Disagree; SD = Strongly Disagree

The quantitative results were reinforced by qualitative evidence from one teacher, who stated:

> *" If the head teacher is interested in DLP, we feel compelled and motivated to use digital tools, even when they present us with challenges."*

This testimonial suggests that leadership influences the relationship between training and DLP upscaling through a motivational process, thereby supporting the proposed moderating role of school leadership.

Pearson correlation analysis was conducted to examine the bivariate relationships between the study variables and DLP upscaling. The analysis aimed to determine the strength and direction of the associations between staff training, provision of digital literacy resources, school leadership quality, and DLP upscaling. The results of the correlation analysis are presented in Table 6.

Table 6

Pearson correlation analysis — study variables and DLP upscaling

Variable	Pearson r	Sig. (2-tailed)	N	Interpretation
Training of Staff	.600**	.000	234	Moderate +ve
Provision of DLP Resources	.112**	.000	234	Weak +ve
School Leadership Quality (Moderator)	.487**	.000	234	Moderate +ve

Notes: **Correlation is significant at the 0.01 level (2-tailed). Source: Field Data (2024)

All three hypotheses were tested using hierarchical moderated multiple regression analysis conducted in two stages. Prior to the analysis, the underlying assumptions of regression were assessed and found to be satisfactory. The residuals were normally distributed, as indicated by the Kolmogorov–Smirnov test ($p > 0.05$). Linearity was confirmed through the examination of scatter plots, which demonstrated linear relationships among the variables. In addition, Variance Inflation Factor (VIF) values below 3.0 indicated the absence of multicollinearity among the predictor variables. To facilitate the moderation analysis and minimize multicollinearity, all continuous variables were mean-centered before computing the interaction terms. The results of the model summary are presented in Table 7, while the corresponding regression coefficients are reported in Table 8.

Table 7

Hierarchical regression model summary

Model	R^2	Adj. R^2	ΔR^2	F (change)
Step 1 (Main effects)	.765	.759	.765	F (3,230) =24.81, p=.000
Step 2 (+ Interaction terms)	.812	.805	.047	F (2,228) =12.74, p=.000

Source: Field Data (2024)

Table 8

Hierarchical moderated regression coefficients

Variable	B	Std. Error	Beta (β)	t	Sig.
Step 1: Main Effects					
(Constant)	.684	.232	—	2.948	.005
Training of Staff (X_1)	.378	.081	.290	3.554	.005
Provision of DLP Resources (X_2)	.595	.087	.495	5.652	.001
School Leadership Quality (M)	.312	.076	.271	4.105	.000
Step 2: Interaction Terms					
$X_1 \times M$ (Training × Leadership)	.218	.064	.198	3.406	.001
$X_2 \times M$ (Resources × Leadership)	.267	.071	.241	3.761	.000

Notes*:* Dependent Variable: DLP Upscaling. All variables mean-centred. Source: Field Data (2024)

In Step 1, which included only the main effects, the regression model was statistically significant, $F(3, 230) = 24.81$, $p < .001$, which explains 76.5% of the variance in DLP upscaling ($R^2 = .765$). These findings are consistent with the results of the bivariate analysis. Staff training had a significant positive effect on DLP upscaling ($\beta = .378$, $t = 3.554$, $p = .005$), while the provision of DLP resources also exerted a significant positive influence ($\beta = .595$, $t = 5.652$, $p = .001$). Consequently, the null hypotheses H_{01} and H_{02} were rejected. School leadership quality was likewise found to be a significant independent predictor of DLP upscaling ($\beta = .312$, $t = 4.105$, $p < .001$). Hence, there is a direct positive effect on programme expansion and implementation.

In Step 2, the interaction terms Training × Leadership and Resources × Leadership were added to the model. The inclusion of these interaction effects resulted in a statistically significant increase in the explained variance ($\Delta R^2 = .047$), $F(2, 228) = 12.74$, $p < .001$. The full moderated model, comprising both the main effects and interaction terms, explained 81.2% of the variance in DLP upscaling. This represents a substantial improvement over the 76.5% explained by the main-effects model alone.

Both interaction terms were statistically significant. The interaction between staff training and school leadership quality had a positive effect on DLP upscaling ($\beta = .218$, $t = 3.406$, $p = .001$), while the interaction between resource provision and school leadership quality was also significant ($\beta = .267$, $t = 3.761$, $p < .001$). These results led to the rejection of H_{03} and provide evidence that school leadership quality significantly moderates the relationships between staff training, resource provision, and DLP upscaling.

The positive and significant interaction coefficients indicate that the effects of staff training and resource provision on DLP upscaling become stronger when school leadership quality is high. Conversely, even when adequate training and resources are available, weaker leadership reduces the extent to which these inputs are translated into successful DLP upscaling. Therefore, the role of school leadership is critical in enhancing the effectiveness of training and resource investments in DLP.

5. Discussion

This study makes three important contributions to the literature on the upscaling of digital education programmes. First, it replicates and extends previous findings by demonstrating that staff training ($\beta = .378$) and the provision of digital literacy resources ($\beta =$

.595) are significant positive predictors of DLP upscaling. The stronger predictive effect of resource provision asserts the critical role of material infrastructure in resource-constrained settings. This supports the argument advanced by Bergson-Shilcock (2020) that access to adequate resources remains a fundamental prerequisite for successful digital transformation.

Second, the findings provide further support for Instructional Leadership Theory by confirming both the direct and indirect influence of school leadership quality on DLP upscaling. School leadership quality emerged as a significant independent predictor ($\beta = .312$), consistent with the propositions of Leithwood et al. (2020). Schools in which head teachers actively champion DLP implementation, allocate resources, and monitor programme progress exhibited substantially higher levels of DLP integration than schools characterized by passive or disengaged leadership. Consistent with the work of Avidov-Ungar et al. (2022), innovation-enabling leadership is associated with stronger technology integration outcomes.

Third, and most importantly, the study provides empirical evidence of a significant moderating effect of school leadership quality on the relationship between staff training, resource provision, and DLP upscaling ($\Delta R^2 = .047$; Training × Leadership $\beta = .218$; Resources × Leadership $\beta = .267$). These results imply that school leadership quality functions not merely as an additive factor but as a multiplier that enhances the effectiveness of both training and resource investments. Consequently, a well-trained teaching workforce operating under strong leadership is more likely to achieve higher levels of DLP upscaling than an equally trained workforce operating under weak leadership. Similarly, a school equipped with adequate digital resources may achieve markedly different outcomes depending on the quality of its leadership. A well-resourced digital library operating within a complacent management environment is unlikely to realize the same benefits as a similar facility managed by engaged and proactive school leaders. This finding provides further evidence on principal support as a key determinant of ICT integration outcomes (Yurtseven Avci et al., 2020) and the moderating role of school leaders' digital literacy philosophies in teachers' technology adoption (Alanoglu et al., 2022).

The moderated model explained 81.2% of the variance in DLP upscaling, which indicates a high level of explanatory power. These findings have significant policy implication: investments in staff training and ICT resource provision alone may not produce optimal outcomes unless they are accompanied by deliberate investments in school leadership

development. Strengthening leadership capacity is therefore essential for maximizing the impact of digital literacy initiatives and achieving sustainable DLP upscaling.

6. Conclusion and Recommendations

This study examined the effects of staff training and the provision of digital literacy resources on DLP upscaling, as well as the moderating role of school leadership quality in publicly funded primary schools in Elgeyo Marakwet County. The results showed that staff training had a significant positive effect on DLP upscaling ($\beta = 0.378$, $p < .05$). Meanwhile, the provision of digital literacy resources emerged as the strongest predictor of DLP upscaling ($\beta = 0.595$, $p < .001$). The results further revealed that school leadership quality significantly moderates the relationships between staff training, resource provision, and DLP upscaling. The moderated model explained 81.2% of the variance in DLP upscaling ($R^2 = 0.812$; $\Delta R^2 = 0.047$), which indicates that the effects of training and resource provision are substantially strengthened when school leadership quality is high. Consequently, H_{03} was rejected.

The successful DLP upscaling in resource-constrained public primary schools requires a three-dimensional approach comprising human capital development through staff training, material infrastructure provision through digital resources, and quality organizational leadership. None of these components is sufficient on its own. The findings extend and support Instructional Leadership Theory by demonstrating that leadership functions as a multiplier rather than merely an additive predictor of DLP outcomes in the Kenyan primary school context. The results also extend the Technology Acceptance Model by suggesting that teachers' perceptions of the usefulness and ease of use of digital tools are influenced by the leadership context within which they operate.

The practical implications of these findings are substantial. Policies that focus solely on the acquisition of digital devices or the delivery of isolated training programmes are unlikely to achieve sustained DLP integration unless accompanied by investments in instructional leadership development. Counties with limited resources, such as Elgeyo Marakwet, should prioritize continuous professional development, pedagogically integrated training programmes, and leadership coaching initiatives that equip head teachers to lead, mentor, and support DLP implementation effectively.

For the Ministry of Education and policymakers, budgetary allocations for DLP implementation should include provisions for continuous teacher development, ICT

infrastructure maintenance, and customized leadership development programmes for head teachers. The establishment of a School Digital Leadership Index (SDLI) could provide a useful benchmark for evaluating school leaders' performance and could be integrated into annual appraisal systems. Training programmes should be designed collaboratively with teachers to address context-specific challenges at the sub-county level and should focus not only on technical skills but also on effective classroom integration. Head teachers should be encouraged to develop their own digital leadership competencies and serve as champions of DLP implementation within their schools. Board of Management (BOM) chairpersons should support dedicated maintenance budgets and establish feedback mechanisms to assess the effectiveness of training initiatives. Regular ICT asset audits should also be conducted. In addition, school leadership should foster a culture in which the use of DLP is routinely practiced, monitored, and recognized.

For non-governmental organizations and development partners, interventions should adopt a three-pronged approach that combines the provision of digital devices, teacher ICT training, and school leadership coaching, particularly in remote sub-counties. Organizations such as Ushahidi, GSMA, and UNESCO IITE should incorporate leadership capacity-building components into both hardware and training investments to maximize the effectiveness and sustainability of DLP initiatives.

This study has several limitations. The research design limits the ability to draw conclusions regarding the long-term effects of training, resource provision, and leadership quality on DLP outcomes. In addition, the use of self-reported Likert-scale measures, particularly for leadership quality, may have introduced social desirability bias. Future studies should therefore incorporate independent observations or formal interviews to validate leadership measures. Furthermore, the findings are specific to Elgeyo Marakwet County and may not be fully generalizable to other contexts. Future research should employ longitudinal designs to examine DLP upscaling over time following integrated interventions involving training, resources, and leadership development. Comparative studies across counties with differing resource and leadership profiles would also help determine the generalizability of the moderation effects observed in this study. Finally, future research should explore whether factors such as sub-county characteristics, school size, and head teacher tenure further influence the moderating role of school leadership in DLP upscaling.

Disclosure statement

The authors declare that there is no conflict of interest with respect to the research, authorship, and/or publication of this article.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Institutional Review Board Statement

Ethical clearance was obtained from the Mount Kenya University Institutional Research Ethics Committee (MKU-IREC) prior to data collection. Written informed consent was obtained from all adult respondents (head teachers, teachers, and QASOs). Parental/guardian consent and learner assent were obtained for student respondents. Participants were informed of their right to withdraw without consequence at any time. All data were handled as confidential, with no personally identifiable information disclosed. The study adhered to the NACOSTI guidelines on research involving human participants.

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