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Research Article

Heterogeneity in Digital Learning Resource Integration: A Multilevel Analysis of Teacher Intern Practices in Secondary Schools Across Homa Bay County, Kenya

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Abstract

Digital learning resources (DLR) are transformative technologies in education. This study investigates their integration in teaching and learning among university teacher interns in secondary schools across Homa Bay County, Kenya, motivated by positive government initiatives and digital literacy policies. It examines the heterogeneity in DLR integration and identifies key factors influencing the infusion of the technologies in classroom practices my university teacher interns. The study assessed how teacher intern attitudes, infrastructural challenges, and pedagogical constraints affect DLR integration. Employing a mixed-methods design, the investigation combined quantitative surveys, classroom observations, and semi-structured interviews to gather data from 105 third-year teacher interns during their practicum placements. The target population, drawn from several Kenyan universities, provided insights into both personal digital competencies and support systems. The findings reveal that teacher interns generally have a positive attitude towards integrating DLR (Mean > 4.5). Findings reveal that the teacher intern attitude significantly influenced the likelihood of teacher interns choosing to integrate digital learning resources (DLR) into their practices (p<0.001, with an R2 value of 0.786). However, the findings show that inadequate technological infrastructure, limited digital literacy and heavy workloads were, among others, the factors that contributed in heterogeneity in integration of the DLR in teaching and learning among the teacher interns. The study concluded that enhancing pre-service training, establishing smart classrooms, and implementing ongoing professional development are essential for optimizing DLR integration. Accordingly, the study recommends policy adjustments, targeted investments, and comprehensive training programs to bridge the digital divide and promote equitable digital education.

Keywords

Digital Learning Resources, Teacher Intern, Heterogeneity in Integration, Teacher Intern, Digital Literacy

1. Introduction

The integration of digital learning resources (DLR) into education systems has emerged as a transformative force in 21st century pedagogy. Kenya positions herself at the forefront of this shift through ambitious policy guidelines such as the Digital Literacy Programme (DLP), Vision 2030 [15] and the information and communication technology in education and training policy [16]. These initiatives aim to bridge the digital divide and foster a knowledge-based economy, particularly in

rural areas where infrastructural challenges persist [21]. However, while government-led information communication and technology (ICT) initiatives have improved educational access in other African countries such as South Africa and Ghana, persistent inequities in rural areas hinder full-scale implementation [26, 2]. Similarly, in Kenya, disparities in resource distribution and utilization remain distinct, creating an uneven landscape for teacher tasked with implementing technology-driven instruction [11]. While this is the case, little is documented about the factors that contribute to heterogeneity in integration of DLR in schools especially among university teacher interns.

Teacher interns play a pivotal role in integrating DLR into classrooms practices. As emerging educators, they are often viewed as agents of pedagogical innovation, however, [19] observe that the student-teachers navigate an uneven ecosystem characterized by systemic infrastructural challenges and limited capacity building opportunities. Similarly, [5] underscores that variability in the teacher intern technological competencies and institutional support systems significantly influences their ability to integrate DLR effectively in teaching and learning. Further, [5] harangue that, while some teacher interns excel in leveraging DLR to facilitate interactive learning, others rely on traditional methods due to limited exposure or confidence in using technology. In a similar vein, [9], observe that teacher interns face challenges of inadequate support, lack of Internet, insufficient ICT skills among users, and high data costs and low ICT literacy levels as a barrier to effective integration of DLR in their practices. The challenges highlighted by [5] and [9] have resulted in heterogeneity in integration of DLR among teacher interns. Such heterogeneity in the DLR adoption practices correlates with divergent learning outcomes, such that classrooms with consistent embracing of the technologies would report higher learner engagement rates. Consequently, the integration of DLR among teacher interns should be encouraged in order to enable them acquire digital competencies essential in effective lesson delivery and desirable learning outcomes.

1.1. Background to the Study

Globally, secondary education systems increasingly rely on DLR to enhance student engagement and personalize learning. For instance, South Africa has utilized digital resources to address educational inequities, though gaps persist in ensuring equitable access for marginalized groups such as students with disabilities [26]. Similarly, [25] emphasizes the importance of technology leadership in Malaysia and teacher training in overcoming barriers to ICT integration. In Kenya's context, urban schools often boast advanced technologies like interactive whiteboards and learning management systems (LMS), while rural institutions frequently lack basic ICT infrastructure, a phenomenon that [4] described as a "digital desert" – areas with limited or lack Internet connectivity. Further, [14] observe that only a fraction of rural schools have

functional computer labs or internet access compounding the challenges faced by teacher interns. Like in Kenya, [1] reveal that similar struggles are experienced in Ethiopia where rural schools face significant barriers to ICT integration due to insufficient teacher training and infrastructure deficits. As such, governments and teacher training institutions in Africa should have deliberate capacity building initiatives to equip both pre-service and in-service skills with digital and pedagogical competencies that would enable them the integrate DLR in the classroom practices.

While the government of Kenya has shown commitment in supporting the integration of DLR in education and training, there are exists gaps emanating from social, cultural, economic and geographical disparities that hinder successful infusion of the technologies in teaching and learning. [31] note that such systemic gaps in digital education landscape create a paradox in that, while DLR hold immense potential to democratize education, their inconsistent implementation in schools, both in urban and rural areas risks exacerbating inequities. [20] observe that factors driving this variability in Kenya include disparities in pedagogical preparedness, access to professional development opportunities, and broader systemic challenges at school and county levels. There is need therefore to conduct more studies to not only determine the causes of the heterogeneity in integration of DLR in teaching and learning but also advise on the best approaches in impacting the relevant competencies among teachers.

The reviewed literature revealed that existing research predominantly focuses on established teachers or general ICT adoption trends without addressing the unique challenges faced by teacher interns who straddle training and practice [30]. Furthermore, studies often focus rural contexts without accounting for county-specific barriers such as frequent power outages and limited broadband coverage [22]. This study seeks to fill these gaps by employing multilevel analytical frameworks grounded in the Kolb's experiential learning theory [10] and connectivism theory [24] to examine how micro-level pedagogical decisions interact with meso-level institutional policies and macro-level infrastructure constraints. Similar approaches have been applied globally to understand how digital tools can be effectively integrated into diverse educational contexts [13].

1.2. Statement of the Problem

A crosscheck during teaching practice assessments over the years by the university supervisor who doubled as the researcher shows that teacher interns in Homa Bay County, Kenya, scantly and variably integrate DLR in their practices. Occasionally, a few teacher interns in different schools in the county would be observed integrating DLR in their classroom practices. The teacher interns encounter uneven opportunities to leverage DLR, resulting in divergent classroom practices and learning outcomes. This research aimed to investigate the causes of the heterogeneity in DLR integration among teacher

interns in Homa Bay County. The study explored factors contributing to this variability to provide actionable recommendations for stakeholders. Policymakers can leverage these insights to optimize digital resource investments; training institutions may recalibrate curricula to address interns' contextual challenges; and school administrators can develop frameworks that cultivate technology-positive cultures within resource-constrained settings. Ultimately, this research advances a nuanced understanding of DLR integration that acknowledges the interplay between personal agency, institutional support systems, and systemic inequities. By centering teacher interns' experiences within the county, it aims to catalyze pedagogical transformation and ensure Kenya's digital education policies translate into equitable classroom practices.

1.3. Purpose and Objective of the Study

The purpose of this study was to investigate the heterogeneity in integration of DLR among teacher interns. The study specifically examined the factors contributing to the variability in digital learning resource integration practices among teacher interns in secondary schools across the Homa Bay County, Kenya.

2. Methodology

2.1. Research Design

This study employed the mixed-methods design, integrating qualitative and quantitative approaches to explore the variability in digital learning resource (DLR) integration among teacher interns in secondary schools in Homa Bay County, Kenya. This approach enabled a comprehensive analysis of the factors contributing to this variability, combining numerical data with detailed insights into the experiences of teacher interns.

2.2. Target Population

The target population comprised the 297 third-year teacher interns from five Kenyan universities: the University of Nairobi, Kenyatta, Tom Mboya, Kisii, and Rongo Universities who were conducting their internship programme in Homa Bay County, Kenya. These interns from these universities undertake their teaching practicum during the second term of the Kenyan secondary school calendar.

2.3. Sampling Technique and Sample Size

Random sampling technique was used to select 105 out of 297 teacher interns actively engaged in teaching practices in Homa Bay County. Random sampling was appropriate for this study because the students from the various universities were not posted evenly and every school had intern teachers from

the five (5) universities. The sampling technique further helped in avoiding bias in selecting the respondents from the five universities.

2.4. Research Instruments and Data Collection Procedure

Data collection spanned six weeks during the practicum period and employed three tools. A structured questionnaire gathered quantitative data on teacher intern attitude towards integration of DLR in their practices. Classroom observations provided qualitative insights into the practical application of DLR while semi-structured interviews captured in-depth perspectives on factors other than attitude determining the teacher interns' probability of integrating DLR in their practices. Data collection was done during the supervisor assessment of the teacher intern practicums. Ethical considerations in the research design were multifaceted in that informed consent was ensured, with participants understanding the study's purpose and risks. Confidentiality and anonymity were maintained by anonymizing data. Respect for participants involved avoiding exploitation and harm. Ethical approval was obtained to validate the design and safeguard rights. Researchers avoided bias and ensured accurate reporting, while being culturally sensitive to local norms in Homa Bay County.

2.5. Data Analysis and Presentation

Qualitative data from questionnaires were analyzed using descriptive statistics (means, percentages, frequencies and standard deviation) to assess teacher intern attitudes towards integrating digital learning resources in their practices and regression analysis conducted to examine the relationship between the teacher intern attitudes and the variability in their responses. Descriptive statistics was also computed to analyse the other factors contributing to the heterogeneity in DLR integration practices among teacher interns. Further, qualitative data from interviews and observations underwent was organized in emerging themes for ease of analysis. Triangulation of both qualitative and quantitative findings was done. Results were presented in tables and figures.

3. Findings and Discussion

3.1. Teacher Intern Attitudes and Variability in Integrating Digital Learning Resources in Their Practices

The study sought to investigate whether teacher intern attitudes and variability in integrating digital learning resources in their practices contributed to heterogeneity in integrating DLR in their practices. A multilevel analysis was conducted to explore the patterns and relationships in the data collected

using a Likert-scale questionnaire. Mean and standard deviation (SD) values were calculated for each item to understand central tendencies and variability as shown in Table 1. A correlation matrix was generated to identify relationships between items.

Table 1. Multilevel Analysis of Teacher Intern Attitudes Towards Integrating Digital Learning Resources.

Item	Mean	SD	Interpretation
I enjoyed integrating digital learning resources in teaching and learning	4.6	0.7	High positive attitude
I avoided integrating digital learning resources whenever I could	2.1	1.0	Moderate negative attitude
I think integrating digital learning resources takes too much time for meant learning	2.3	0.9	Low concern
The integration of digital learning resources helped me to be creative in lesson delivery	4.5	0.8	High positive impact
Planning to integrate digital learning resources in lesson delivery intimidated me	2.0	1.1	Low intimidation
Successful integration depends on learners' proficiency	3.9	0.9	Moderate agreement
I would be a better teacher if I knew how to integrate digital learning resources	4.2	0.8	High agreement
I am confident working with digital learning resources	4.3	0.7	High confidence
Integrating digital learning resources improved my teaching skills	4.4	0.8	High positive impact
I fear integrating digital learning resources due to potential failure	2.2	1.0	Low fear
Integrating digital learning resources helped deliver abstract concepts	4.5	0.7	High effectiveness
digital learning resources facilitates effective learning	4.6	0.6	High facilitation
I often integrated digital learning resources for student engagement	4.3	0.8	High engagement

The data in Table 1 reveal that teacher interns generally have a positive attitude towards integrating DLR with high mean scores for items related to enjoyment, effectiveness and confidence, all with a mean above 4.5. The findings corroborate with studies indicating that positive attitudes towards educational technology enhance its adoption by teachers in their classroom practices [7]. Conversely, concerns such as fear of failure (Mean = 2.2) and intimidation (Mean = 2.0) were low, suggesting that teacher interns feel relatively comfortable with digital tools, possibly due to prior exposure or training. The correlation analysis highlighted strong positive relationships between confidence in using technology and its perceived effectiveness (r >.7).

A simple regression analysis was conducted to examine the relationship between the mean scores (representing overall attitudes or responses) and the variability (standard deviation) in those responses. By regressing the mean on the standard deviation (SD), the analysis sought to determine whether variability in opinions was systematically associated with the average sentiment, potentially reflecting consensus or disagreement among respondents. The results revealed a strong negative relationship between SD and mean scores (r = -0.886). The model was highly statistically significant (p<0.001, with an R^2 value of 0.786), indicating that approximately 79% of the variance in mean scores could be explained by the standard deviation.
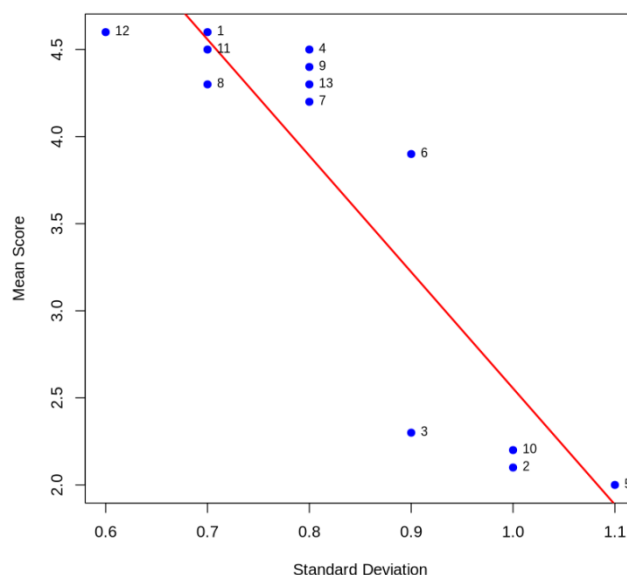

Figure 1. Simple Regression Analysis Examining The Relationship Between The Mean Scores (Representing Overall Attitudes Or Responses) and The Variability (Standard Deviation) In Those Responses.

The findings suggest that items with higher mean scores

(indicating more positive attitudes toward technology integration) exhibited lower variability in responses, whereas items with lower mean scores (reflecting negative attitudes) demonstrated greater variability among respondents. This pattern implies a higher degree of consensus regarding positive perceptions of technology integration in teaching, while negative perceptions were more heterogeneous across participants. These results underscore that the predictor variable "Teacher intern attitude" significantly influenced the likelihood of teacher interns choosing to integrate digital learning resources (DLR) into their practices. The outcomes align with recent studies, such as those by [27] and [7] who emphasize the critical role of teacher attitudes in determining technology adoption in educational settings. These findings highlight the importance of pre-service programmes at the universities to foster teacher confidence by providing comprehensive training on digital skills.

3.2. Other Factors Contributing to the Heterogeneity in Digital Learning Resource Integration Practices Among Teacher Interns

The study sought to examine how infrastructural, teacher competencies and pedagogical factors contribute to the heterogeneity in digital learning resource integration practices among teacher interns in Homa Bay County, Kenya. The data collected was presented in Table 2.

Table 2. Multilevel Analysis of The Factors Contributing to Heterogeneity in Digital Learning Resources Integration Practice Among University Teacher Interns.

Factor Category	Example Factors	Frequency	Percentage
Infrastructural factors	Inadequate technological equipment such as projectors, computers, laptops; Poor mobile network connectivity; lack of reliable Wi-Fi/internet, Unreliable power supply and frequent power outages	55	61.10%
Teacher Digital Competencies	Limited digital literacy and insufficient training, Lack of technical know-how/confidence, Low personal motivation to explore digital tools	20	22.20%
Pedagogical Factors	Heavy workload and limited lesson time for integrating technology, Administrative pressure to complete the syllabus rapidly, Challenges in aligning digital resource use with effective lesson planning and classroom management	15	16.70%

Table 2 shows the multilevel analysis of teacher intern responses on factors contributing to heterogeneity in DLR integration practice among university teacher interns. Data in Table 2 reveal that infrastructural factors (61.1%) which encompasses deficiencies such as inadequate technological equipment such as projectors, computers, laptops and digital devices; poor mobile network coverage; lack of reliable Wi-Fi/internet and unreliable power supply as the main factors contributing to heterogeneity in DLR integration practice among university teacher interns. The finding were supported by [7] who observe that such physical constraints contribute to the inconsistent use of digital resources and directly affected technology integration in the classroom. The responses indicated in Table 2 were verified through lesson observations on availability of DLR and frequency of integration in lessons by the teacher interns. Among the sampled schools, 60% of them had power connectivity though the governments last milestone project of connecting public institution to the national grid, however, suffered severe power outages and/or they did not have computers, laptops, projectors and related digital learning resources to support the teacher interns in their classroom practices. Among the teacher interns who were involved in the study, only 9 of them representing about 10% of the sample size that were observed integrating digital resources in their classroom practices by use of YouTube videos downloaded through their own mobile phones. It was observed that 90% of the teacher interns did not attempt to integrate digital learning resources in the classroom. On the contrary, the lesson plans reviewed indicated that 84% of the teacher interns had planned to use at least one digital resources. Of these lesson plans reviewed, 55% of them had been prepared using an electronic word processing software. The findings indicated that, teacher interns were willing and ready to integrate DLR in their practice, but the inadequacies in availability and access to these resources hindered most of them from doing so. Schools should thus, make deliberate effort to setup smart classrooms equipped with the relevant DLR in order to support the teacher interns to integrate the technologies in teaching and learning. In support of this viewpoint, one of the teacher interns interviewed reported the following:

TI023: *I am ready to integrate ICT and digital resources in my lessons because I have my own laptop, but the problem is that the entire school has only one projector used by a few*

regular teachers. Getting it is a challenge for me plus power blackouts are too frequent. The school does not have Internet connectivity. Teacher buy own Internet bundles and sometimes travel over 15 kilometers to the nearest market to access cyber services. The school or the government should to something facilitate us, the teachers.

Teacher digital competencies, representing 22.2% of responses as shown in Table 2, included challenges such as limited digital literacy, insufficient training, and a lack of confidence in using technology. These issues indicate that even if resources are available, many teacher interns may struggle to employ digital tools effectively without enhanced professional development [24]. This indicates that there in a need for the universities to enriching their pre-service teacher training programmes to equip the learners with more digital literacy competencies through targeted training to improve personal digital competencies among teacher trainees and addressing pedagogical factors through curriculum redesigns. Additionally, schools should conduct in-service professional development programmes to foster effective digital integration in teaching and learning. Such programmes would benefit teacher interns in their schools.

Further, as indicated in Table 2, pedagogical factors (16.7%) involve factors related to the instructional design process such as heavy workload, time constraints that prevent thorough lesson planning, administrative pressures that force rapid syllabus completion and difficulties in aligning technology with effective pedagogy. From lesson plans reviewed, it was observed that over 85% of the teacher interns were ahead of the schemes of work (Sow) plans. One of the teacher interns interviewed reported that there were instruction from the school management through the head of departments to maximize the remedial lessons in order to complete the second term's schemed content and start term three work ahead of time, which bars them prepare technology integrated lessons. [29] underscore that integrating of DLR is not merely a technological issue but also one of pedagogical strategy. Consequently, curriculum implementation supervisors in schools should ease the pressure of completing the syllabus earlier than recommended in the curriculum designs to allow teacher interns to plan well and integrate DLR in their classroom practices.

4. Conclusion and Recommendations

4.1. Conclusion

The study concludes that teacher intern attitudes significantly influence the heterogeneity in the integration of DLR in classroom practices, with those holding positive attitudes being more likely to adopt DLR than their counterparts with negative attitudes. Additionally, the heterogeneity observed in DLR integration among teacher interns in secondary schools in Homa Bay County, Kenya, was attributed to infrastructural, pedagogical, and digital competency factors.

4.2. Recommendations

The study recommends that pre-service programs at universities should build teacher confidence by offering comprehensive training in digital skills. Additionally, schools are encouraged to set up smart classrooms equipped with relevant DLR to help teacher interns integrate these tools into their practices. Furthermore, in-service professional development programs should be implemented to support effective DLR integration in teaching and learning, thereby benefiting teacher interns at their schools. Finally, curriculum implementation supervisors in schools should alleviate the pressure to complete the syllabus prematurely, allowing teacher interns ample time to plan and integrate DLR into their classroom practices. To further understand the heterogeneity of DLR integration among interns, this study recommends exploration of the interplay between institutional leadership, policy frameworks, and socio-economic contexts in shaping the teachers' adoption of digital tools. The study further recommends a comparative study across diverse geographical and cultural settings, and the gender factor to reveal contextual and gender-based barriers or enablers not evident in Homa Bay County.

Abbreviations

DLP	Digital Literacy Programme
DLR	Digital Learning Resource
ICT	Information Communication and Technology
LMS	Learning Management Systems
SD	Standard Deviation

Author Contributions

Peter Kyalo Mulwa is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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