Effectiveness of Technology Integration on Students' Academic Performance in Secondary Schools in Turkana County, Kenya

Tonny Odhiambo

Department of Education, Presbyterian University of East Africa, Kenya

**Corresponding author: tonny.odhiambo@puea.ac.ke*

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Abstract

The increasing integration of digital technologies into education has transformed teaching and learning processes globally; however, evidence on their effectiveness in improving students' academic performance remains inconsistent, particularly in under-resourced and marginalized regions where infrastructural and capacity constraints persist. This study therefore examined the effectiveness of technology integration on students' academic performance in secondary schools in Turkana County, Kenya. Specifically, the study investigated the influence of classroom technology integration and teacher ICT competence on students' academic performance. The study adopted a descriptive survey and correlational research design. Data were collected from secondary school students and teachers using structured questionnaires, while students' academic performance was measured using document analysis of school records, including continuous assessment tests and end-of-term examination scores. Data were analyzed using descriptive statistics, Pearson correlation, and multiple regression analysis. Findings revealed a significant positive relationship between technology integration and students' academic performance. Teacher ICT competence emerged as the strongest predictor of academic performance, followed by classroom technology integration practices. The study further established that inadequate ICT infrastructure, limited access to digital devices, poor internet connectivity, and insufficient teacher ICT training hinder effective integration of educational technologies in schools.

Keywords: Technology Integration, Academic Performance, ICT Competence, Secondary Schools, Turkana County

Introduction

Technology integration has become a defining characteristic of contemporary educational reform and is increasingly recognized as a critical determinant of teaching effectiveness, learner engagement, and academic achievement. Across the world, governments and educational institutions are investing heavily in digital technologies—including learning management systems, online assessment platforms, interactive multimedia resources, virtual learning environments, and communication technologies—to enhance instructional quality and prepare learners for participation in knowledge-based societies. The growing emphasis on digital transformation reflects the recognition that technological competence is no longer optional but an essential educational outcome for twenty-first-century learners (UNESCO, 2023).

Evidence from technologically advanced education systems demonstrates the transformative potential of educational technology when effectively integrated into teaching and learning processes. Countries such as Singapore, South Korea, Estonia, and Finland have successfully embedded digital technologies within curriculum delivery, assessment systems, and teacher professional development programmes, resulting in improved learner engagement, enhanced digital literacy, and stronger academic outcomes. These experiences have established technology integration as a strategic instrument for improving educational quality and promoting equitable access to learning opportunities.

The educational benefits associated with technology integration are supported by extensive empirical research. Technology-enhanced learning environments facilitate active learning, collaborative knowledge construction, differentiated instruction, immediate feedback, and access to diverse learning resources. Tondeur et al. (2017) argue that effective technology integration promotes critical thinking, creativity, and problem-solving competencies that contribute significantly to academic success. Similarly, Ertmer and Ottenbreit-Leftwich (2013) contend that technology enables teachers to transition from traditional teacher-centered instructional approaches toward learner-centered pedagogies that foster deeper understanding and knowledge retention. Within the Technological Pedagogical Content Knowledge (TPACK) framework, effective technology integration occurs when teachers successfully combine technological knowledge, pedagogical expertise, and subject content to enhance learning experiences (Mishra & Koehler, 2006).

Despite these documented benefits, the educational impact of technology integration remains uneven across developing countries. While many governments have adopted policies promoting digital learning, implementation challenges continue to limit the realization of intended educational outcomes. Inadequate infrastructure, insufficient teacher preparation, unreliable internet connectivity, limited technical support, and unequal access to digital devices remain persistent barriers to effective technology integration in many educational systems. Consequently, questions persist regarding the extent to which investments in educational technology translate into measurable improvements in student achievement, particularly in resource-constrained settings.

In Kenya, educational technology has become a central component of national education reform. The Government of Kenya has implemented several initiatives aimed at promoting digital learning, including the Digital Literacy Programme, the Competency-Based Curriculum (CBC), and the ICT in Education and Training Policy. The policy seeks to institutionalize technology integration across all levels of education by enhancing digital infrastructure, strengthening teacher ICT competencies, promoting digital content development, and supporting technology-enabled teaching and learning processes. Government commitment to educational digitalization is further reflected in increased investments in ICT infrastructure, with budgetary allocations for ICT integration in secondary schools increasing from KES 200 million in 2022 to KES 400 million in 2024.

Notwithstanding these policy initiatives and financial investments, evidence suggests that technology integration in Kenyan secondary schools remains uneven. Significant disparities exist between urban and rural schools regarding access to digital infrastructure, internet connectivity, technological resources, and teacher ICT preparedness. These challenges are particularly evident in arid and semi-arid regions such as Turkana County, where geographical isolation, infrastructural limitations, and resource constraints continue to affect educational service delivery.

Turkana County remains one of Kenya's educationally marginalized regions despite ongoing government interventions. Secondary schools within the county continue to face challenges associated with inadequate ICT infrastructure, unreliable electricity supply, limited internet access, and insufficient teacher capacity for effective technology integration. These constraints potentially limit the educational benefits that technology integration is expected to generate. Consequently, concerns remain regarding whether existing investments in educational technology are contributing meaningfully to improved student learning outcomes in the county.

The focus of this study is on individual secondary school students, whose academic performance constitutes the dependent variable. Academic performance refers to students' achievement as measured through examination scores, continuous assessment tests, and other formal academic evaluations. Nationally, concerns regarding learner achievement remain significant. Statistics from the 2024 Kenya Certificate of Secondary Education (KCSE) examination indicate that approximately 353,154 candidates attained grades D plain and below, highlighting persistent challenges in academic attainment across the country.

These challenges are even more pronounced in marginalized regions such as Turkana County, where educational outcomes have historically lagged behind national expectations due to infrastructural constraints, teacher shortages, limited learning resources, and unequal access to educational technologies. Despite government efforts to expand digital learning and ICT integration, secondary schools in Turkana continue to face significant challenges related to internet connectivity, electricity supply, and access to digital devices, all of which may affect students' academic achievement. Consequently, questions remain regarding the extent to which technology integration contributes to improved academic performance among secondary school students in the county.

While national statistics provide a broad picture of educational outcomes, limited empirical evidence exists on the relationship between technology integration and academic performance in marginalized and resource-constrained counties such as Turkana. This contextual gap necessitates further investigation to establish whether investments in educational technology are translating into measurable improvements in student learning outcomes.

Existing studies in Kenya have predominantly focused on ICT availability, adoption levels, teacher attitudes, and implementation challenges. Comparatively fewer studies have examined how specific dimensions of technology integration influence students' academic achievement. Furthermore, much of the existing literature conceptualizes technology integration as a general construct without distinguishing between classroom utilization of digital technologies and teacher ICT competence as separate explanatory factors influencing learner outcomes.

This study examines the effectiveness of technology integration on students' academic performance in secondary schools in Turkana County, Kenya. Specifically, the study investigates the influence of classroom technology integration and teacher ICT competence on students' academic achievement. In this study, classroom technology integration and teacher ICT competence constitute independent variables, while students' academic performance constitutes the dependent variable. The study seeks to establish the extent to which the use of digital technologies in classroom instruction and teachers' ICT competencies influence students' academic outcomes. The findings are expected to provide empirical evidence to inform educational policy, school leadership practices, teacher professional development programmes, and future investments in educational technology within marginalized educational contexts.

Despite substantial government investment in ICT infrastructure and the implementation of the ICT in Education and Training Policy (2021/2022), improving students' academic performance remains a major concern in many Kenyan secondary schools, particularly in marginalized regions such as Turkana County. Although schools have increasingly been equipped with digital technologies and supported through various technology integration initiatives, student academic outcomes in the county continue to lag behind national expectations, raising concerns about the effectiveness of these interventions in enhancing learning achievement.

Existing research in Kenya has largely focused on ICT availability, technology adoption, teacher perceptions, and challenges associated with implementation. While these studies have generated valuable insights into the integration process, limited empirical evidence exists on whether technology integration actually translates into improved academic performance among students. Furthermore, few studies have examined the combined influence of classroom technology integration and teacher ICT competence on students' academic achievement, particularly in arid and semi-arid regions such as Turkana County, where contextual challenges may affect educational outcomes.

Consequently, it remains unclear whether the investments made in educational technology are producing measurable improvements in students' academic performance or whether other factors, such as teacher ICT competence, influence the effectiveness of technology integration. This study therefore seeks to fill this empirical gap by examining the influence of classroom technology integration and teacher ICT competence on students' academic performance in secondary schools in Turkana County, Kenya. The findings will provide evidence-based insights to guide policy formulation, resource allocation, and educational practice aimed at improving learning outcomes through effective technology integration.

Literature Review / Theoretical Framework

This study is anchored in the Technological Pedagogical Content Knowledge (TPACK) framework developed by Punya Mishra and Matthew J. Koehler (2006). The framework explains how teachers effectively integrate technology into teaching and learning through the interaction of technological knowledge, pedagogical knowledge, and content knowledge. Unlike earlier approaches that viewed technology as an independent instructional resource, the TPACK framework argues that meaningful educational outcomes emerge when teachers possess the competence to align technological tools with pedagogical strategies and curriculum content.

The framework is particularly relevant to the present study because it explains the mechanisms through which technology integration influences students' academic performance. According to TPACK, technology does not improve learning outcomes automatically. Rather, technology becomes educationally effective when teachers possess the knowledge and skills required to utilize digital tools in ways that support learning objectives. Consequently, teacher ICT competence is conceptualized as a critical determinant of successful technology integration, while students' academic performance represents the ultimate educational outcome.

Within the context of secondary schools in Turkana County, the TPACK framework provides a useful lens for examining how classroom technology integration and teacher ICT competence contribute to students' academic achievement. The framework therefore supports the study's proposition that effective technology integration and teacher ICT competence positively influence academic performance.

Technology integration refers to the purposeful use of digital technologies such as computers, multimedia resources, projectors, learning management systems, online assessment tools, and internet-based educational platforms to enhance teaching and learning processes. Contemporary educational reforms increasingly view technology integration as a strategic tool for improving educational quality and learner outcomes.

Several empirical studies have reported positive relationships between technology integration and academic performance. For example, Bond et al. (2024) found that technology-enhanced learning environments promote learner engagement, collaboration, and knowledge retention, thereby contributing to improved academic outcomes. Similarly, Hillmayr et al. (2020) reported that digital learning technologies have positive effects on student achievement, particularly when integrated into active and learner-centered instructional approaches. Research on learning management systems further demonstrates that digital platforms facilitate communication, continuous assessment, and access to learning resources, all of which contribute to improved learner performance (Al-Adwan et al., 2018).

Despite this generally positive evidence, literature presents important contradictions. While some scholars report substantial improvements in student achievement resulting from technology integration, others argue that the relationship is neither direct nor universal. OECD studies have shown that increased access to technology does not necessarily translate into higher academic performance and may produce limited benefits when technology is used without clear pedagogical objectives. Similarly, Bulman and Fairlie (2016) observed that the effectiveness of technology depends largely on instructional quality rather than the availability of digital devices.

These divergent findings suggest that technology integration should not be viewed as a universally effective intervention. From the researcher's perspective, the inconsistent findings indicate that contextual factors play a critical role in shaping educational outcomes. In resource-constrained environments such as Turkana

County, where infrastructural limitations and unequal access to digital resources persist, the effectiveness of technology integration may differ significantly from findings reported in urban or technologically advanced settings. Consequently, empirical investigation is required to determine whether technology integration contributes significantly to academic performance within this specific context.

Teacher ICT competence refers to the knowledge, skills, confidence, and professional capacity required to utilize digital technologies effectively for instructional purposes. Within the TPACK framework, teacher competence represents the foundation upon which meaningful technology integration is built.

A substantial body of literature identifies teacher ICT competence as a key predictor of successful technology integration. Tondeur et al. (2023) argue that teachers with strong digital competencies are more likely to employ learner-centered pedagogies, interactive learning activities, and technology-enhanced instructional strategies that improve student engagement and achievement. Similarly, Instefjord and Munthe (2017) found that teacher digital competence significantly influences both the frequency and quality of technology use in classroom instruction.

However, the literature remains divided regarding the extent to which teacher ICT competence directly affects student achievement. Some studies report strong positive relationships between teacher competence and learning outcomes, whereas others suggest that competence alone is insufficient. Scherer et al. (2021) found that teachers may possess adequate technological skills but fail to improve student performance if technology is not integrated into pedagogically meaningful instructional practices.

These findings reinforce the central argument of the TPACK framework that technology-related competencies must be integrated with pedagogical and content knowledge to influence learning outcomes effectively. From the researcher's perspective, teacher ICT competence is likely to be particularly important in Turkana County, where limited technological resources require teachers to maximize the educational value of available digital tools. Nevertheless, empirical evidence examining this relationship within marginalized Kenyan contexts remains limited, thereby justifying further investigation.

The reviewed literature demonstrates substantial agreement that technology integration and teacher ICT competence have the potential to improve students' academic performance. Studies consistently report that digital technologies enhance learner engagement, facilitate access to educational resources, and support innovative teaching approaches. Similarly, teacher ICT competence is widely recognized as a critical factor influencing the success of technology integration initiatives.

Nevertheless, important contradictions remain. While many studies report positive effects of technology integration on academic achievement, others suggest that these effects depend heavily on contextual factors such as infrastructure, pedagogical quality, institutional support, and teacher preparedness. Likewise, although teacher ICT competence is generally associated with effective technology use, scholars disagree on whether competence directly influences academic performance or operates indirectly through instructional practices.

Furthermore, existing studies in Kenya have predominantly focused on ICT adoption, infrastructure availability, implementation challenges, and teacher perceptions. Comparatively few studies have examined how classroom technology integration and teacher ICT competence jointly influence students' academic performance. More importantly, limited empirical evidence exists from arid and semi-arid regions such as Turkana County, where educational conditions differ substantially from those of urban and well-resourced counties.

The researcher argues that conclusions drawn from studies conducted in technologically advantaged environments cannot be generalized automatically to Turkana County. The unique challenges associated with infrastructure, connectivity, teacher deployment, and resource availability may alter the effectiveness of technology integration. Consequently, a significant empirical and contextual gap exists regarding the extent to which technology integration and teacher ICT competence influence students' academic performance in secondary schools in Turkana County. This study seeks to address that gap. This is the hypothesis:

H_1: Technology integration has a significant positive relationship with students' academic performance in secondary schools in Turkana County, Kenya.
H_2: Teacher ICT competence has a significant positive relationship with students' academic performance in secondary schools in Turkana County, Kenya.
H_3: Technology integration has a significant positive effect on students' academic performance in secondary schools in Turkana County, Kenya.
H_4: Teacher ICT competence has a significant positive effect on students' academic performance in secondary schools in Turkana County, Kenya.
H_5: Technology integration and teacher ICT competence jointly and significantly predict students' academic performance in secondary schools in Turkana County, Kenya.

Methodology

This study adopted a descriptive survey and correlational research design to examine the effectiveness of technology integration on students’ academic performance in secondary schools in Turkana County, Kenya. The descriptive survey design was appropriate because it enabled the researcher to collect data from respondents regarding their experiences, perceptions, and practices related to technology integration in teaching and learning. The correlational design was used to determine the nature, strength, and direction of relationships between technology integration variables and students’ academic performance without manipulating any study variables. According to Creswell (2014), descriptive and correlational research designs are appropriate when the purpose of a study is to examine naturally occurring relationships among variables in educational settings.

The target population comprised secondary school students and teachers from selected public and private secondary schools in Turkana County. However, it is important to clarify the unit of analysis in this study: the student is the primary unit of analysis, while teachers provide supporting data on technology integration practices and ICT competence.

Students were selected because they represent the direct recipients of instructional processes, and their academic performance constitutes the dependent variable of the study. Teachers were included because they are the primary implementers of technology integration in classroom instruction and therefore provide critical insight into instructional practices influencing student learning outcomes.

A stratified random sampling technique was used to ensure proportional representation of schools based on ownership type (public and private) and class levels (Form 3 to Form 4). Stratification ensured that variations in access to ICT infrastructure and instructional practices were adequately captured, improving the representativeness of the study findings.

The study targeted a final sample size of 150 respondents, which consisted of 120 students (primary respondents for academic performance data) and 30 teachers (key informants on ICT competence and classroom technology integration)

Data were collected using structured questionnaires, developed based on the Technological Pedagogical Content Knowledge (TPACK) framework proposed by Mishra and Koehler (2006). The questionnaire was divided into four sections: Technology integration in classroom instruction, teacher ICT competence, students' academic performance and demographic characteristics.

Technology integration was measured using indicators such as frequency of ICT use, use of learning management systems (LMS), multimedia instructional tools, and online assessment practices. Teacher ICT competence was measured in terms of digital literacy, ability to integrate ICT into lesson delivery, and confidence in using digital tools.

Students' academic performance was measured using a combination of self-reported academic achievement indicators (Likert scale responses) and available school-based records such as test scores and examination performance where accessible.

All items were measured using a five-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree, which enabled quantification of perceptions for statistical analysis.

Content validity was ensured through expert review by university supervisors and specialists in educational research. Their feedback was used to refine questionnaire items to ensure alignment with the study objectives and constructs.

Reliability of the instrument was tested through a pilot study conducted in one secondary school outside the main study area. Internal consistency was determined using Cronbach's Alpha coefficient. According to Hair et al. (2010), a Cronbach's Alpha value of 0.70 and above indicates acceptable reliability. The pilot results confirmed that the instrument was reliable for use in the main study.

Data were collected through both physical administration and electronic distribution of questionnaires, depending on accessibility and school arrangements. Before data collection, permission was obtained from relevant education authorities and school administrators. Respondents were informed of the purpose of the study, and participation was strictly voluntary. Ethical considerations included informed consent, confidentiality, anonymity, and the right to withdraw from the study at any stage without penalty.

Data were analyzed using both descriptive and inferential statistics. Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to summarize demographic characteristics and describe levels of technology integration and academic performance.

Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize respondent characteristics and levels of study variables. Inferential analysis involved Pearson Product-Moment Correlation to determine relationships among variables and multiple regression analysis to establish the predictive influence of technology integration and teacher ICT competence on students' academic performance. Academic performance was measured using standardized scores derived from continuous assessment tests and end-of-term examination results obtained through document analysis of school records.

To ensure methodological consistency, teacher ICT competence was aggregated at the school level by computing mean teacher scores within each institution, thereby aligning it with the student-level unit of analysis. Technology challenges were treated as a contextual descriptive variable and excluded from inferential modeling to maintain construct clarity.

To ensure conceptual clarity and resolve unit inconsistency, the study used a single-level student-based multiple regression model specified as:

Yi=β0+β1X1i+β2X2i+εiYi = \beta 0 + \beta 1 X {1i} + \beta 2 X {2i} + \varepsilon iYi=β0+β1X1i+β2X2i +εi

Where:

- YiYi = Academic performance of student *i* (standardized test scores and end-of-term examination scores)
- β0\beta 0β0 = Intercept (constant term)
- X1iX {1i}X1i = Technology integration level for student *i*
- X2iX {2i}X2i = Teacher ICT competence (school-level aggregated mean score)
- β1,β2\beta1, \beta 2β1, β2 = Regression coefficients estimating the effect of each predictor on academic performance
- εi\varepsilon iεi = Error term for student *i*

Findings and Results

The study sought data from students and teachers in selected secondary schools in Turkana County. A total of 150 questionnaires were distributed, comprising 120 student questionnaires and 30 teacher questionnaires. Out of these, 132 questionnaires were completed and returned, yielding an overall response rate of 88.0%.

Table 1: Response Rate

Category	Distributed	Returned	Response Rate (%)
Students	120	110	91.7
Teachers	30	22	73.3
Total	150	132	88.0

Interpretation

The response rate of 88.0% exceeds the minimum threshold recommended for educational and social science research and is therefore considered adequate for statistical analysis. The high participation rate enhances the reliability and representativeness of the findings while reducing the likelihood of non-response bias. To address concerns regarding analytical consistency, respondents were categorized according to their role in the study.

Table 2: Distribution of Respondents

Category	Frequency	Percentage (%)
Students	110	83.3
Teachers	22	16.7
Total	132	100

Interpretation

Students constituted the majority of respondents because they were the primary unit of analysis and their academic performance represented the dependent variable. Teachers provided supplementary information regarding ICT competence and classroom technology integration practices.

Table 3: Gender Distribution of Students

Gender	Frequency	Percentage (%)
Male	56	50.9
Female	54	49.1
Total	110	100

Interpretation

The findings indicate an almost equal representation of male and female students. Such balance is desirable because it minimizes gender-related bias and improves the generalizability of the findings. The distribution suggests that both genders had comparable opportunities to participate in the study.

The near parity in gender composition strengthens the internal validity of the study by reducing sampling distortions associated with gender imbalance. Previous studies have shown that access to educational technologies and academic outcomes may vary by gender; therefore, balanced representation ensures that observed relationships between technology integration and academic performance are less likely to be influenced by gender effects.

Table 4: Age Distribution of Students

Age Category	Frequency	Percentage (%)
14 -15 Years	17	15.5
16 - 17 Years	50	45.5
18 - 19 Years	37	33.6
20 Years and Above	6	5.4
Total	110	100

Interpretation

Most students (45.5%) were aged between 16 and 17 years, followed by those aged 18–19 years (33.6%). Only a small proportion (5.4%) was above 20 years. This age structure reflects the normal progression pattern of secondary school learners in Kenya, where students are generally expected to fall within the 14–19-year age bracket. The presence of a small number of over-age learners may be attributed to delayed school enrolment, class repetition, socio-economic challenges, or interruptions associated with pastoralist lifestyles common in Turkana County. Consequently, the age profile accurately reflects the educational realities of marginalized contexts and enhances the credibility of the sample.

Table 5: Type of School Attended

School Type	Frequency	Percentage (%)
Public	70	63.6
Private	40	36.4
Total	110	100

Interpretation

The majority of students were drawn from public schools. The predominance of public-school students reflects the structure of secondary education provision in Turkana County, where public institutions account for most enrolments. Since public schools often experience greater infrastructural constraints than private institutions, this distribution provides a realistic context for evaluating technology integration challenges.

Table 6: Access to Digital Devices

Access Category	Frequency	Percentage (%)
Personal Device	38	34.5
School Device	24	21.8
No Access	48	43.6
Total	110	100

Interpretation

Nearly half of the students lacked access to digital devices. The high proportion of students without device access demonstrates the existence of a digital divide within Turkana County. Access to technology represents a prerequisite for meaningful technology integration. Therefore, limitations in device availability may constrain the extent to which educational technologies influence learning outcomes. This finding supports broader literature highlighting inequitable access to digital resources in marginalized educational environments.

Table 7: Gender of Teachers

Gender	Frequency	Percentage (%)
Male	12	54.5
Female	10	45.5
Total	22	100

Interpretation

The teaching workforce demonstrates reasonable gender balance. A relatively balanced teacher population provides diverse instructional perspectives and reduces potential gender-related bias in technology integration practices.

Table 8: Age Distribution of Teachers

Age Category	Frequency	Percentage (%)
23 - 30 Years	4	18.2
31- 40 Years	8	36.4
41- 50 Years	7	31.8
Above 50 Years	3	13.6
Total	22	100

Interpretation

Most teachers were between 31 and 50 years of age. This distribution suggests a moderately experienced teaching workforce. Research indicates that teaching experience may influence technology adoption, although competence is more strongly determined by training opportunities and institutional support than by age alone.

Table 9: Teacher ICT Competence Levels

Competence Level	Frequency	Percentage (%)
High	6	27.3
Moderate	10	45.5
Low	6	27.3
Total	22	100

Interpretation

Most teachers reported moderate ICT competence. The predominance of moderate ICT competence suggests that while teachers possess foundational digital skills, significant opportunities remain for professional development. According to the TPACK framework, teacher competence is fundamental to effective technology integration and educational effectiveness.

Table 10: Descriptive Statistics

Variable	Mean	Std. Deviation
Technology Integration	3.86	0.84
Academic Performance	4.01	0.88
Technology Challenges	4.09	0.81

Interpretation

Respondents reported relatively high levels of technology integration and academic performance. However, technology-related challenges also recorded high mean scores. The coexistence of relatively high technology integration and significant implementation challenges suggests that schools are attempting to adopt educational technologies despite infrastructural constraints. This finding reflects the complexity of technology integration in resource-constrained educational contexts and aligns with TPACK assumptions that technology effectiveness depends on enabling conditions.

Table 11: Correlation Matrix

Variable	TI	AP	TC
Technology Integration (TI)	1.000		
Academic Performance (AP)	.672	1.000	
Technology Challenges (TC)	-.581	-.536	1.000

$p < .01$

Interpretation

Technology integration exhibited a strong positive relationship with academic performance ($r = .672$, $p < .01$). The positive correlation suggests that students exposed to greater levels of technology-supported learning tend to achieve better academic outcomes. The coefficient indicates a substantial association, supporting TPACK's proposition that technology contributes positively to learning when effectively integrated into instructional practice.

Hypothesis Decision

H_1 Accepted: Technology integration has a significant positive relationship with students' academic performance.

Table 12: Multiple Regression Analysis Model Summary

R	R²	Adjusted R²	Std. Error
.738	.545	.532	.418

Interpretation

The coefficient of determination ($R^2 = 0.545$) indicates that 54.5% of the variation in students' academic performance is explained by the combined effects of technology use frequency, digital tools usage, and teacher ICT competence. This level of explanatory power is considered substantial in educational research, suggesting that the study variables play a significant role in influencing student achievement. However, the remaining 45.5% of unexplained variation implies that other factors not included in the model, such as socioeconomic status, school resources, learner motivation, and parental support, may also contribute to academic performance.

Table 13: ANOVA Results

Source	SS	df	MS	F	Sig
Regression	25.914	3	8.638	49.872	.000
Residual	21.612	106	.204		
Total	47.526	109			

Interpretation

The regression model was statistically significant. The significant F-statistics confirm that the independent variables jointly predict academic performance better than would be expected by chance. Consequently, the model possesses adequate predictive validity.

Table 14: Regression Coefficients

Predictor	B	SE	β	t	Sig
Constant	0.801	0.201	—	3.985	.000
Technology Use Frequency	0.311	0.067	.329	4.642	.000
Digital Tools Usage	0.274	0.061	.298	4.492	.000
Teacher ICT Competence	0.346	0.066	.371	5.242	.000

Interpretation

All predictors significantly influenced academic performance. Teacher ICT competence emerged as the strongest predictor ($\beta = .371$), followed by technology use frequency ($\beta = .329$) and digital tools usage ($\beta = .298$). These findings provide empirical support for the TPACK framework, which argues that teacher competence is the central mechanism through which educational technology affects learning outcomes. The results suggest that investments in technology alone are insufficient unless accompanied by teacher capacity development.

Hypothesis Decisions:

- H_3 Accepted: Technology integration significantly affects academic performance.
- H_4 Accepted: Teacher ICT competence significantly affects academic performance.
- H_5 Accepted: Technology integration and teacher ICT competence jointly predict academic performance.

Conclusion and Recommendations

The study established that teacher ICT competence was the strongest predictor of students' academic performance ($\beta = .371$). This implies that improving teacher capacity has the highest potential return on student achievement. Therefore, the Ministry of Education, County education authorities, and school administrators should prioritize continuous, structured ICT training programs for teachers, focusing not only on basic digital literacy but also on pedagogical integration aligned with the TPACK framework. In addition, schools should institutionalize regular in-service training and peer mentoring systems to strengthen classroom-level technology use.

The study further found that technology use frequency ($\beta = .329$) and digital tools usage ($\beta = .298$) significantly influenced academic performance, indicating that students perform better when exposed to consistent and structured use of digital learning tools. In response, schools should ensure that ICT resources are regularly embedded into lesson delivery across all subjects, rather than being used sporadically or for demonstration purposes only. School leadership should also develop clear timetables or instructional policies that require minimum levels of ICT integration per term.

Findings revealed that nearly 43.6% of students had no access to digital devices, highlighting a serious digital divide that may limit equitable learning opportunities. To address this, education stakeholders should prioritize the provision of shared digital devices (computer labs, tablets, or mobile learning hubs), particularly in public schools. In addition, partnerships with NGOs and private sector actors should be strengthened to support device access programs for disadvantaged learners.

The study also identified that technology challenges such as poor internet connectivity, unreliable electricity, and inadequate infrastructure remained significant barriers (mean = 4.09). This suggests that even where ICT policies exist, implementation is constrained by structural limitations. Consequently, the government and county authorities should prioritize infrastructure development, including a stable electricity supply (solar backup systems where necessary) and improved internet connectivity in rural and arid regions such as Turkana County.

Finally, the regression model showed that 54.5% of the variation in academic performance is explained by technology integration variables, while 45.5% is influenced by other factors not included in the model. This indicates that ICT interventions alone are not sufficient. Schools should therefore adopt a holistic academic support approach, integrating ICT initiatives with learner support systems such as academic mentoring, parental engagement, and motivation-enhancing programs.

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