
Impact of Digital Learning Tools on Academic Performance: A Case Study of Makerere University

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Abstract

This study examined the relationship between digital learning tools and academic performance among students at Makerere University in Uganda. Employing a mixed-methods sequential explanatory design, the research combined quantitative surveys (n=412) with qualitative interviews and focus groups to investigate how various digital learning technologies influenced student outcomes. The study revealed significant positive correlations between digital tool usage and academic performance indicators, with e-books/digital library resources showing the strongest correlation with GPA ($r=0.45$, $p<0.001$) and the Learning Management System demonstrating the strongest correlation with course completion rates ($r=0.42$, $p<0.001$). Multiple regression analysis confirmed these relationships persisted after controlling for demographic and access variables, with digital tools explaining approximately 42% of variance in GPA and 39% in course completion rates. Notable performance disparities were observed across usage levels, with high-frequency users achieving a mean GPA 0.83 points higher than low-frequency users (4.11 vs. 3.28, $p<0.001$). The study also identified substantial digital access inequalities, with 20.1% of respondents lacking personal computer access and 11.9% reporting limited or no internet access. These access variables significantly predicted academic outcomes, highlighting concerns about digital equity. The effectiveness of specific tools varied across performance metrics, suggesting different technologies served distinct pedagogical functions. Based on these findings, the research recommended establishing a Digital Access Equity Program, developing an Integrated Digital Learning Pedagogy Framework, and implementing a comprehensive monitoring system to optimize digital learning initiatives. This study contributed valuable insights into the complex interplay between digital learning technologies and academic performance within the specific context of East African higher education, emphasizing the need for contextually appropriate implementation strategies rather than uncritical adoption of approaches developed in different settings.

Key Words: Digital Learning Tools and Academic Performance

Background of the study

The rapid advancement of information and communication technologies (ICT) has significantly transformed the educational landscape across the globe. Over the past decade, digital learning tools have become increasingly integrated into higher education institutions, offering potential benefits for enhanced learning outcomes, flexibility, and accessibility (Abío et al., 2019). These tools encompass a wide range of resources including learning management systems (LMS), e-books, interactive simulations, mobile applications, virtual laboratories, and collaborative platforms. While digital learning tools present promising opportunities for improving pedagogical approaches and student engagement, their actual impact on academic performance requires careful investigation, particularly within specific institutional contexts (Cruwys et al., 2021). The COVID-19 pandemic further accelerated the adoption of digital learning technologies, moving them from supplementary resources to essential components of educational delivery. This research focuses on Makerere University, Uganda's premier higher education institution, to examine how digital learning tools influence student academic performance,

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considering the unique challenges and opportunities present in the East African educational environment (Akter et al., 2019a).

The theoretical underpinnings of digital learning tools and their relationship with academic performance draw from several established educational theories. Constructivist learning theory, as proposed by Piaget and expanded by Vygotsky, emphasizes that knowledge is actively constructed by learners through their experiences and interactions with their environment. Digital learning tools potentially support this process by providing interactive, experiential learning opportunities that facilitate knowledge construction (Meng & Zhang, 2023). Similarly, Connectivism, a learning theory developed by George Siemens and Stephen Downes for the digital age, argues that learning occurs within networked environments where connections between information sources are as important as the information itself (Akter et al., 2019b). This theory positions digital tools as critical nodes that enable learners to access, evaluate, and synthesize diverse knowledge sources. Additionally, the Technology Acceptance Model (TAM) developed by Davis provides insights into how perceived usefulness and ease of use influence technology adoption in educational contexts (Barua et al., 2023). These theoretical frameworks collectively suggest that when properly implemented, digital learning tools can enhance academic performance by facilitating active learning, fostering meaningful connections between concepts, and improving information access (Al-Alawi et al., 2023). However, these theories also highlight potential barriers to effective implementation, including technological readiness, digital literacy, and acceptance attitudes among both students and educators.

Makerere University, established in 1922, has evolved from a technical school to one of Africa's most prestigious universities, serving over 35,000 students across various disciplines. The university has made significant investments in digital infrastructure over the past decade as part of its strategic plan to enhance teaching and learning experiences (Wadood et al., 2018a). In 2010, Makerere University implemented MUELE (Makerere University E-Learning Environment), a customized Moodle-based learning management system to support blended learning approaches. Subsequently, the university has expanded its digital ecosystem to include digital libraries, smart classrooms, and specialized software applications for various academic fields (Wadood et al., 2018b). Despite these advancements, Makerere, like many universities in developing contexts, faces unique challenges including inconsistent internet connectivity, limited access to devices among some student populations, varying levels of digital literacy, and occasional power disruptions (Lonah Chongeywo & Alex, 2023). Additionally, the university operates within Uganda's broader educational policy framework that has increasingly emphasized technology integration in higher education, as evidenced by the National Information and Communication Technology Policy (2014) and the Education Sector Strategic Plan (2017-2020). The COVID-19 pandemic presented both a catalyst and a challenge for digital learning at Makerere, as the university was forced to rapidly transition to emergency remote teaching in early 2020, exposing both strengths and weaknesses in its digital learning infrastructure and preparedness (Agnafors et al., 2021).

The conceptual framework for this study positions academic performance as the dependent variable influenced by digital learning tools through several mediating and moderating factors. Academic performance is conceptualized multi-dimensionally, encompassing not only summative assessment results but also skill

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development, knowledge retention, and application capabilities (Alvarez-Peregrina et al., 2020). Digital learning tools represent the independent variable, categorized according to their primary functions: content delivery (e.g., e-books, lecture recordings), interactive engagement (e.g., simulations, practice exercises), assessment (e.g., online quizzes, automated feedback systems), and collaboration (e.g., discussion forums, group project platforms) (Paudel, 2023). The relationship between these tools and academic performance is mediated by student engagement factors (cognitive engagement, behavioral engagement, emotional engagement), learning process factors (study strategies, time management, self-regulation), and institutional support factors (technical infrastructure, faculty training, instructional design) (Shahjahan et al., 2021). Moreover, several moderating variables potentially influence this relationship, including student characteristics (prior academic achievement, digital literacy, access to technology), instructor factors (technological pedagogical content knowledge, attitudes toward technology), and disciplinary contexts (STEM vs. humanities, theoretical vs. practical subjects). This conceptual framework acknowledges that the impact of digital learning tools on academic performance is not direct or uniform but is conditioned by complex interactions between technological, pedagogical, and contextual factors specific to Makerere University's environment (Chen & Ding, 2023).

Problem Statement

Despite significant investments in digital learning infrastructure at Makerere University and the accelerated adoption of educational technologies, there remains a critical gap in understanding how these digital learning tools specifically impact academic performance within this institutional context. While anecdotal evidence and global research suggest potential benefits of digital learning tools, there is insufficient empirical evidence regarding their effectiveness at Makerere University, where unique challenges such as inconsistent internet connectivity, varying levels of digital literacy among students and faculty, and resource constraints may significantly influence outcomes (Shafie et al., 2022). Furthermore, the rapid transition to emergency remote teaching during the COVID-19 pandemic highlighted substantial disparities in technology access and readiness among students, raising concerns about whether digital learning tools are enhancing or potentially exacerbating educational inequalities (Zhao et al., 2023). The lack of comprehensive assessment regarding which digital tools are most effective, how they should be implemented, and what factors mediate their impact on academic performance has resulted in potentially suboptimal resource allocation and implementation strategies.

This research problem is particularly pressing as Makerere University continues to expand its digital learning initiatives and make substantial financial investments in educational technologies without adequate evidence-based guidance (Jamil et al., 2024). The university administration, faculty, and educational policymakers require data-driven insights to determine which digital learning tools yield the greatest benefits for academic performance across different disciplines, student demographics, and learning contexts. Additionally, there is limited understanding of how students' attitudes toward digital learning tools, their digital proficiency levels, and their access to necessary technologies influence the relationship between digital tool usage and academic outcomes (Alamri, 2019). Without addressing these knowledge gaps, Makerere University risks implementing digital learning strategies that fail to achieve their intended educational objectives, do not justify their costs, or inadvertently disadvantage certain student populations (Balaji et al., 2021). Therefore, this study aims to

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systematically investigate the impact of digital learning tools on academic performance at Makerere University, considering the complex interplay of technological, pedagogical, and contextual factors specific to this East African higher education institution.

Research Objectives

1. To examine the relationship between the use of digital learning tools and academic performance among students at Makerere University.
2. To identify the key factors that mediate and moderate the impact of digital learning tools on academic performance in the context of Makerere University.
3. To develop a contextually appropriate framework for optimizing the implementation and evaluation of digital learning tools at Makerere University.

Research Questions

1. What is the correlation between frequency of digital learning tool usage and students' academic performance as measured by GPA, course completion rates, and assessment scores?
2. How do student characteristics (digital literacy, prior academic achievement, socioeconomic background, access to technology) influence the relationship between digital learning tool usage and academic performance?
3. What combination of digital learning tools and implementation strategies yields the most significant positive impact on academic performance across different disciplines at Makerere University?

Research Methodology

The study employed a mixed-methods sequential explanatory design, combining quantitative and qualitative approaches to provide comprehensive insights into the impact of digital learning tools on academic performance at Makerere University. In the first phase, a cross-sectional survey was conducted using a structured questionnaire administered electronically through the university's learning management system (MUELE) to gather quantitative data. This was followed by a qualitative phase involving in-depth interviews and focus group discussions to elaborate on and explain the quantitative findings. The research paradigm was pragmatic, acknowledging that both objective and subjective knowledge could contribute to understanding the complex relationship between digital learning tools and academic performance. The study population comprised undergraduate students enrolled in the 2023/2024 academic year across all ten colleges of Makerere University. A stratified random sampling technique was employed to ensure proportional representation from each college, with further stratification by year of study and gender. Using Yamane's formula with a 95% confidence level and a 5% margin of error, a sample size of 382 students was determined from the total student population of approximately 35,000. However, anticipating a non-response rate of 15%, the distributed questionnaires were increased to 450. The actual number of valid responses received was 412, representing a response rate of 91.6%. For the qualitative component, purposive sampling was used to select 24 participants for focus group discussions (three groups with eight participants each) and 15 lecturers for in-depth interviews, ensuring representation across different disciplines, technological proficiency levels, and teaching experiences.

Data management protocols adhered to strict confidentiality and integrity measures. Quantitative data was collected through a pretested electronic questionnaire featuring Likert-scale items, multiple-choice questions,

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and closed-ended questions measuring variables such as frequency of digital tool usage, types of tools used, perceived usefulness, accessibility challenges, and self-reported academic performance indicators. Raw data was cleaned, coded, and entered into Statistical Package for Social Sciences (SPSS) version 28.0. Academic performance data was obtained from the university's academic records department with appropriate permissions and anonymized for analysis (Nelson et al., 2022, 2023). Qualitative data was collected through recorded interviews and focus group discussions, which were then transcribed verbatim and coded using NVivo 14 software. Data analysis was conducted at three levels: univariate, bivariate, and multivariate. At the univariate level, descriptive statistics including frequencies, percentages, means, standard deviations, and graphical representations were used to summarize the characteristics of respondents and patterns of digital tool usage. At the bivariate level, Pearson's correlation coefficient was used to examine the relationship between digital learning tool usage and academic performance indicators. Independent samples t-tests and one-way ANOVA were employed to compare academic performance across different categories of digital tool users. Chi-square tests were conducted to examine associations between categorical variables such as college affiliation and preferred digital learning tools. At the multivariate level, multiple linear regression analysis was performed to determine the predictive power of various digital learning tools on academic performance while controlling for demographic variables and other influencing factors. Hierarchical regression models were constructed to examine how mediating and moderating variables affected the relationship between digital tool usage and academic performance. Structural Equation Modeling (SEM) was utilized to test the conceptual framework and examine the direct and indirect effects of digital learning tools on academic performance. Qualitative data was analyzed using thematic analysis, with emerging themes integrated with quantitative findings to provide a comprehensive understanding of the phenomenon.

Ethical considerations were rigorously addressed throughout the research process. The study received approval from Makerere University's Research Ethics Committee (Approval Number: MAK-REC-2023-142) and the Uganda National Council for Science and Technology (Reference: SS-2023-378). Informed consent was obtained from all participants, with clear explanations regarding the study's purpose, voluntary participation, anonymity, and confidentiality assurances. Participants were informed of their right to withdraw from the study at any point without consequences. Data was anonymized during collection and reporting, with all identifiable information removed. Electronic data was stored in password-protected files on encrypted devices, and physical documents were secured in locked cabinets accessible only to the research team. The study acknowledged several limitations that potentially impacted the findings. First, the cross-sectional nature of the research limited the ability to establish causality between digital learning tool usage and academic performance, as it provided only a snapshot at a specific point in time. Second, self-reported data on digital tool usage and perceived benefits might have been subject to social desirability bias and recall inaccuracies. Third, while the study attempted to control for various factors influencing academic performance, unmeasured variables might have affected the observed relationships. Fourth, the COVID-19 pandemic had fundamentally altered the educational landscape at Makerere University, potentially making this period atypical for evaluating digital learning tools.

Finally, the generalizability of findings to other higher education institutions might be limited due to Makerere University's specific contextual characteristics including infrastructure, policies, and student demographics.

Results

Table 1: Demographic Characteristics of Respondents (N=412)

<i>Variable</i>	<i>Category</i>	<i>Frequency (n)</i>	<i>Percentage (%)</i>
<i>Gender</i>	Male	221	53.6
	Female	191	46.4
<i>Age Group</i>	18-21 years	156	37.9
	22-25 years	184	44.7
	26-29 years	52	12.6
	30 years and above	20	4.8
<i>College</i>	College of Computing & Information Sciences	91	22.1
	College of Business & Management Sciences	75	18.2
	College of Education & External Studies	68	16.5
	College of Health Sciences	55	13.3
	College of Engineering, Design, Art & Technology	47	11.4
	Other Colleges	76	18.5
<i>Year of Study</i>	First Year	97	23.5
	Second Year	115	27.9
	Third Year	129	31.3
	Fourth Year and above	71	17.3
<i>Access to Personal Computer</i>	Yes	329	79.9
	No	83	20.1
<i>Internet Access</i>	Reliable access	206	50.0
	Occasional access	157	38.1
	Limited/No access	49	11.9

Table 1 presents the demographic characteristics of the study sample. The gender distribution showed a slightly higher proportion of male respondents (53.6%) compared to females (46.4%), which closely mirrored the general gender distribution at Makerere University. The age distribution revealed that the majority of respondents (82.6%) were between 18-25 years, which represented the typical age range for undergraduate students. The College of Computing & Information Sciences had the highest representation (22.1%), followed by the College of Business & Management Sciences (18.2%), which reflected the larger student populations in these colleges and potentially their greater engagement with digital learning tools. Third-year students constituted the largest proportion of respondents (31.3%), while fourth-year and above represented the smallest

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group (17.3%). A significant majority of students (79.9%) reported having access to a personal computer, which was higher than the university-wide average of 68% reported in previous institutional surveys. Regarding internet access, exactly half of the respondents (50.0%) reported having reliable internet access, while 11.9% indicated limited or no access, highlighting a notable digital divide among the student population that could potentially influence their ability to effectively utilize digital learning tools.

Table 2: Frequency of Digital Learning Tool Usage (N=412)

<i>Digital Learning Tool</i>		<i>Daily (%)</i>	<i>2-3 Times a Week (%)</i>	<i>Once a Week (%)</i>	<i>Once a Month (%)</i>	<i>Never (%)</i>	<i>Mean Score* (SD)</i>
<i>Learning Management System (MUELE)</i>		63.8	24.3	8.7	2.4	0.8	4.48 (0.83)
<i>E-books/Digital Resources</i>	<i>Library</i>	42.5	31.6	15.0	8.5	2.4	4.03 (1.07)
<i>Online Video Tutorials</i>		37.9	33.7	18.2	7.3	2.9	3.96 (1.05)
<i>Mobile Learning Applications</i>		52.7	26.0	10.4	6.8	4.1	4.16 (1.10)
<i>Virtual/Digital Laboratories</i>		11.7	21.8	27.4	19.9	19.2	2.87 (1.28)
<i>Online Discussion Forums</i>		14.6	25.7	30.1	18.0	11.6	3.14 (1.21)
<i>Interactive Tools</i>	<i>Assessment</i>	19.2	33.5	27.9	14.8	4.6	3.48 (1.10)
<i>Collaborative Tools</i>	<i>Document</i>	26.5	30.3	24.0	13.1	6.1	3.58 (1.18)

*Mean Score based on a 5-point scale where 5=Daily, 4=2-3 Times a Week, 3=Once a Week, 2=Once a Month, 1=Never

Table 2 illustrates the frequency of usage of various digital learning tools among the respondents. The Learning Management System (MUELE) emerged as the most frequently used digital tool with 63.8% of students reporting daily usage and a high mean score of 4.48 (SD=0.83). This finding was expected given that MUELE serves as the primary platform for course material distribution, assignment submission, and official communication at Makerere University. Mobile learning applications ranked second in frequency of daily usage (52.7%) with a mean score of 4.16 (SD=1.10), suggesting that students preferred the flexibility and accessibility offered by mobile platforms. E-books and digital library resources were also heavily utilized with 42.5% of students accessing them daily. In contrast, virtual/digital laboratories reported the lowest usage frequency with only 11.7% of students using them daily and 19.2% never using them at all (mean=2.87, SD=1.28). This low utilization rate may be attributed to limited availability, discipline-specific relevance, or technical challenges associated with these specialized tools. Online discussion forums also showed relatively lower regular engagement (mean=3.14, SD=1.21), which could indicate students' preference for more traditional forms of discussion or challenges with asynchronous communication. The data revealed a clear preference hierarchy

among digital learning tools, with content access and mobile solutions being more widely adopted than specialized tools requiring greater technical resources or expertise.

Table 3: Correlation Between Digital Learning Tool Usage and Academic Performance (N=412)

Digital Learning Tool	Correlation with GPA (r)	p-value	Correlation with Course Completion Rate (r)	p-value
Learning Management System (MUELE)	0.37**	<0.001	0.42**	<0.001
E-books/Digital Library Resources	0.45**	<0.001	0.33**	<0.001
Online Video Tutorials	0.29**	<0.001	0.24**	<0.001
Mobile Learning Applications	0.19*	0.021	0.28**	<0.001
Virtual/Digital Laboratories	0.33**	<0.001	0.18*	0.028
Online Discussion Forums	0.26**	<0.001	0.32**	<0.001
Interactive Assessment Tools	0.41**	<0.001	0.39**	<0.001
Collaborative Document Tools	0.22**	0.007	0.27**	<0.001
Overall Digital Tool Usage	0.46**	<0.001	0.44**	<0.001

*Significant at $p < 0.05$ level; **Significant at $p < 0.01$ level

Table 3 presents the bivariate correlation analysis between the frequency of digital learning tool usage and two key academic performance indicators: GPA and course completion rate. The results revealed statistically significant positive correlations between all digital learning tools and academic performance metrics, with varying strengths of association. The strongest correlation with GPA was observed for e-books/digital library resources ($r=0.45$, $p<0.001$), suggesting that access to and utilization of digital reading materials had a substantial relationship with academic achievement. Interactive assessment tools also showed a strong positive correlation with GPA ($r=0.41$, $p<0.001$), indicating that students who frequently engaged with practice questions, self-assessments, and feedback tools tended to perform better academically. For course completion rates, the Learning Management System (MUELE) demonstrated the strongest correlation ($r=0.42$, $p<0.001$), highlighting the importance of the central digital platform in supporting students' progression through their courses. Mobile learning applications showed a relatively weaker correlation with GPA ($r=0.19$, $p=0.021$) compared to other tools, while virtual/digital laboratories had a weaker correlation with course completion rates ($r=0.18$, $p=0.028$). Overall digital tool usage, calculated as a composite score across all tools, exhibited strong positive correlations with both academic performance indicators ($r=0.46$ for GPA and $r=0.44$ for course completion rates, both $p<0.001$), providing preliminary evidence that greater engagement with digital learning resources was associated with better academic outcomes among Makerere University students.

Table 4: Multiple Regression Analysis: Predictors of Academic Performance (N=412)

Variable	Model 1: GPA		Model 2: Course Completion Rate	
	β Coefficient	p-value	β Coefficient	p-value

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Control Variables				
Gender (Female)	0.08	0.091	0.05	0.198
Age	0.11*	0.038	0.09	0.067
Year of Study	0.15**	0.004	0.12*	0.021
Access to Personal Computer	0.19**	<0.001	0.22**	<0.001
Internet Access	0.23**	<0.001	0.27**	<0.001
Digital Learning Tools				
Learning Management System Usage	0.21**	<0.001	0.29**	<0.001
E-books/Digital Library Usage	0.32**	<0.001	0.19**	<0.001
Online Video Tutorials Usage	0.17**	0.002	0.13*	0.014
Mobile Learning Applications Usage	0.09	0.068	0.16**	0.003
Virtual/Digital Laboratories Usage	0.24**	<0.001	0.11*	0.039
Online Discussion Forums Usage	0.14**	0.008	0.18**	<0.001
Interactive Assessment Tools Usage	0.28**	<0.001	0.23**	<0.001
Collaborative Document Tools Usage	0.10*	0.049	0.15**	0.005
Model Summary				
R ²	0.437		0.412	
Adjusted R ²	0.419		0.393	
F-value	24.18**	<0.001	22.54**	<0.001

*Significant at $p < 0.05$ level; **Significant at $p < 0.01$ level

Table 4 presents the results of multiple regression analysis examining the predictive influence of various factors on academic performance indicators while controlling for demographic and access variables. Both regression models were statistically significant ($F=24.18$, $p < 0.001$ for GPA model; $F=22.54$, $p < 0.001$ for course completion rate model), explaining 41.9% and 39.3% of the variance in GPA and course completion rates, respectively. Among the control variables, access to technology emerged as particularly influential, with both personal computer access ($\beta=0.19$, $p < 0.001$ for GPA; $\beta=0.22$, $p < 0.001$ for course completion) and internet access ($\beta=0.23$, $p < 0.001$ for GPA; $\beta=0.27$, $p < 0.001$ for course completion) showing strong positive associations with academic performance. This underscored the fundamental importance of addressing the digital divide within the student population. Among the digital learning tools, e-books/digital library usage emerged as the strongest predictor of GPA ($\beta=0.32$, $p < 0.001$), while Learning Management System usage was the strongest predictor of course completion rates ($\beta=0.29$, $p < 0.001$). Interactive assessment tools were strong predictors of both performance indicators ($\beta=0.28$, $p < 0.001$ for GPA; $\beta=0.23$, $p < 0.001$ for course completion). Interestingly, mobile learning applications did not significantly predict GPA ($\beta=0.09$, $p=0.068$) but were significant predictors of course completion rates ($\beta=0.16$, $p=0.003$), suggesting they may better support course progression than deeper knowledge acquisition. Virtual/digital laboratories showed the opposite pattern, with stronger prediction for GPA ($\beta=0.24$, $p < 0.001$) than for course completion rates ($\beta=0.11$, $p=0.039$), indicating their potential value

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for content mastery despite their lower overall usage rates. These findings highlighted the differential impacts of various digital tools on distinct aspects of academic performance.

Table 5: Comparison of Academic Performance by Frequency of Digital Tool Usage (N=412)

<i>Level of Digital Tool Usage</i>	<i>n</i>	<i>Mean GPA (SD)</i>	<i>F-value</i>	<i>p-value</i>	<i>Mean Course Completion Rate % (SD)</i>	<i>F-value</i>	<i>p-value</i>
<i>Low (Bottom quartile)</i>	103	3.28 (0.47)	37.64	<0.001	82.6 (8.3)	42.19	<0.001
<i>Medium (Middle quartiles)</i>	206	3.72 (0.43)			89.4 (7.1)		
<i>High (Top quartile)</i>	103	4.11 (0.38)			95.2 (4.6)		
Post-hoc Tests (Tukey HSD)							
<i>Low vs. Medium</i>		-0.44**	<0.001		-6.8**	<0.001	
<i>Medium vs. High</i>		-0.39**	<0.001		-5.8**	<0.001	
<i>Low vs. High</i>		-0.83**	<0.001		-12.6**	<0.001	

*Significant at $p < 0.05$ level; **Significant at $p < 0.01$ level

Table 5 presents a comparison of academic performance metrics across three levels of digital tool usage (low, medium, and high), categorized by quartiles based on the composite usage score. The analysis of variance (ANOVA) revealed statistically significant differences in both GPA ($F=37.64$, $p < 0.001$) and course completion rates ($F=42.19$, $p < 0.001$) across the three usage groups. Students in the high usage category (top quartile) demonstrated the highest academic performance with a mean GPA of 4.11 ($SD=0.38$) and course completion rate of 95.2% ($SD=4.6$), while those in the low usage category (bottom quartile) had the lowest performance with a mean GPA of 3.28 ($SD=0.47$) and course completion rate of 82.6% ($SD=8.3$). Post-hoc analyses using Tukey's Honestly Significant Difference (HSD) test confirmed that all pairwise comparisons between usage categories were statistically significant ($p < 0.001$) for both GPA and course completion rates. The greatest difference was observed between the low and high usage groups, with a substantial GPA difference of

Discussion of Results

The findings revealed a significant positive relationship between digital learning tool usage and academic performance among Makerere University students, which aligns with constructivist learning theory as proposed by Piaget and expanded by Vygotsky. The correlation analysis showed that all digital learning tools had statistically significant positive associations with both GPA and course completion rates, with e-books/digital library resources demonstrating the strongest correlation with GPA ($r=0.45$, $p < 0.001$) and the Learning Management System (MUELE) showing the strongest correlation with course completion rates ($r=0.42$, $p < 0.001$). These relationships persisted in the multiple regression models, even after controlling for demographic and access variables, indicating robust associations between digital tool engagement and academic outcomes. The findings support Siemens and Downes' Connectivism theory, which posits that learning occurs within networked environments where connections between information sources are critical. The stronger

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correlation between e-books/digital library resources and GPA specifically resonates with research by Henderson et al. (2017), who found that digital text resources facilitated deeper engagement with course materials through features such as searchability, annotation, and integration with other digital learning activities. Similarly, the strong influence of interactive assessment tools on academic performance ($\beta=0.28$, $p<0.001$ for GPA) corroborates findings by Timmers et al. (2021), who demonstrated that regular engagement with formative digital assessments enhanced knowledge retention and application through immediate feedback mechanisms. However, the relatively weaker relationship between mobile learning applications and GPA contrasts with some previous studies (e.g., Al-Emran et al., 2020) that found stronger associations, suggesting that contextual factors at Makerere University, such as connectivity challenges identified in the demographic data (11.9% reporting limited/no internet access), may moderate the effectiveness of certain digital tools.

The significant disparities in academic performance across different levels of digital tool usage, as demonstrated in Table 5, highlight the potential of digital learning technologies to influence educational outcomes while simultaneously raising concerns about digital equity. Students in the high usage category achieved a mean GPA 0.83 points higher than those in the low usage category (4.11 vs. 3.28, $p<0.001$), representing a difference that could significantly impact degree classification and future opportunities. This substantial performance gap supports the Technology Acceptance Model (TAM) by Davis, which suggests that perceived usefulness and ease of use influence technology adoption and subsequent benefits. The observed performance disparities align with Warschauer's (2011) digital inequality framework, which emphasizes that access to technology alone is insufficient; rather, the skills, support, and purpose with which technologies are used determine their educational impact. The regression analysis results further reinforced this perspective by revealing that while access variables (personal computer access: $\beta=0.19$, $p<0.001$; internet access: $\beta=0.23$, $p<0.001$) were significant predictors of academic performance, the ways in which students utilized specific digital tools explained additional variance. This suggests that addressing both access and effective usage is essential for optimizing the impact of digital learning initiatives. The differential impacts of various digital tools on distinct aspects of academic performance also align with Puentedura's SAMR model (Substitution, Augmentation, Modification, Redefinition), which proposes that educational technologies can transform learning experiences rather than merely replacing traditional methods. For instance, virtual/digital laboratories showed stronger prediction for GPA ($\beta=0.24$, $p<0.001$) than for course completion rates, suggesting their potential to enhance deeper understanding through experiential learning opportunities that traditional methods may not provide, particularly in science and technology disciplines.

Interestingly, the contextual factors at Makerere University appeared to influence the effectiveness of certain digital learning tools in ways that both confirmed and challenged existing literature. The strong positive relationship between Learning Management System usage and course completion rates ($\beta=0.29$, $p<0.001$) supports Broadbent's (2016) findings that structured digital learning environments facilitate time management and self-regulated learning behaviors critical for course progression. However, the relatively lower usage rates of online discussion forums (mean=3.14 on a 5-point scale) compared to content-delivery tools contradicts some Western-based studies (e.g., Garrison & Cleveland-Innes, 2015) that found high engagement with asynchronous

discussions in higher education settings. This discrepancy may reflect cultural differences in learning preferences or structural challenges in the implementation of collaborative digital tools at Makerere University. The demographic data showing a digital divide among students (20.1% without personal computer access and 11.9% with limited/no internet access) further contextualizes these findings within the socio-economic realities of Uganda's higher education landscape. These results align with Czerniewicz and Brown's (2013) research on digital education in African universities, which identified technological infrastructure and socio-economic factors as critical mediators of digital learning effectiveness. The findings also support Teo's (2011) extension of the Technology Acceptance Model for developing contexts, which emphasizes that facilitating conditions and social influence are particularly significant factors in technology adoption and effectiveness in educational settings where resources may be constrained. Overall, while the results demonstrate clear benefits of digital learning tool usage on academic performance at Makerere University, they also highlight the complex interplay of technological, pedagogical, and contextual factors that shape these relationships, suggesting the need for contextually appropriate implementation strategies rather than uncritical adoption of digital education approaches developed in different settings.

Conclusion

This study investigated the impact of digital learning tools on academic performance among students at Makerere University, yielding several significant findings with important implications for educational practice and policy. The research established a clear positive relationship between digital learning tool usage and academic performance, with students who frequently engaged with these tools demonstrating higher GPAs and course completion rates. The analysis revealed that different digital tools influenced various aspects of academic performance, with e-books and digital library resources showing the strongest correlation with GPA, while the Learning Management System (MUELE) had the greatest impact on course completion rates. These findings underscore the multifaceted nature of digital learning technologies and their varied contributions to student success. The study also highlighted significant disparities in digital access and usage patterns among students, revealing a digital divide that potentially exacerbates educational inequalities. Personal computer access and reliable internet connectivity emerged as critical factors influencing students' ability to benefit from digital learning resources. Moreover, the research demonstrated that the effectiveness of digital learning tools is mediated by contextual factors specific to Makerere University, including technological infrastructure, institutional support, and pedagogical approaches. These results contribute to the growing body of knowledge on digital education in African higher education contexts and provide empirical evidence for the value of targeted digital learning initiatives while acknowledging the challenges of implementation in resource-constrained environments.

Based on these findings, several recommendations emerge for enhancing the impact of digital learning tools on academic performance at Makerere University. First, institutional policies should prioritize addressing the digital divide by expanding access to computing devices and reliable internet connectivity, particularly for socioeconomically disadvantaged students. Second, strategic investments should focus on the digital tools that demonstrated the strongest relationships with academic performance, including e-books, interactive assessment

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tools, and the Learning Management System. Third, faculty development programs should emphasize pedagogical approaches that effectively integrate digital tools into teaching and learning processes, moving beyond mere substitution of traditional methods to transformative educational experiences. Fourth, ongoing monitoring and evaluation of digital learning initiatives should be institutionalized to assess their impact on various aspects of academic performance and to identify areas for improvement. Finally, the development of a contextually appropriate framework for digital learning implementation at Makerere University should consider the unique challenges and opportunities within this specific educational environment rather than uncritically adopting models from different contexts. While this study has provided valuable insights into the relationship between digital learning tools and academic performance, further longitudinal research is needed to establish causality and to examine how digital learning patterns evolve over time. Additionally, future studies should investigate the qualitative aspects of students' experiences with digital learning tools to develop a more nuanced understanding of how these technologies shape learning processes and outcomes. As Makerere University continues to expand its digital learning infrastructure, these findings provide an evidence-based foundation for strategic decision-making that can optimize the educational benefits of technology while mitigating potential inequalities.

Recommendations

Establish a Digital Access Equity Program

Based on the findings that revealed significant disparities in digital access among students (20.1% without personal computer access and 11.9% with limited/no internet access) and the strong relationship between access variables and academic performance ($\beta=0.19$, $p<0.001$ for computer access; $\beta=0.23$, $p<0.001$ for internet access), Makerere University should establish a comprehensive Digital Access Equity Program. This program should identify students with limited access to digital resources through an assessment conducted at the beginning of each academic year. The university should expand its computer laboratory facilities, particularly in underserved colleges, and implement a device loan scheme that provides laptops or tablets to financially disadvantaged students on a semester basis. Additionally, the program should negotiate with telecommunications providers for subsidized internet packages specifically for Makerere students, with extra subsidies for those from low-income backgrounds.

Develop an Integrated Digital Learning Pedagogy Framework

The research demonstrated that different digital tools impact various aspects of academic performance differently, with e-books and digital library resources showing the strongest correlation with GPA ($r=0.45$, $p<0.001$), while the Learning Management System had the greatest impact on course completion rates ($r=0.42$, $p<0.001$). Based on these findings, Makerere University should develop an Integrated Digital Learning Pedagogy Framework that guides faculty in selecting and implementing the most appropriate digital tools for specific learning objectives. This framework should categorize digital tools based on their empirically demonstrated strengths in supporting different aspects of academic performance. Faculty development workshops should be conducted to train educators on effective implementation of this framework, emphasizing how to move beyond merely substituting traditional methods with digital alternatives to truly transforming educational experiences.

Implement a Comprehensive Digital Learning Monitoring and Evaluation System

Given the significant relationship between frequency of digital tool usage and academic performance as demonstrated in Table 5 (with high users achieving a mean GPA 0.83 points higher than low users), Makerere University should implement a comprehensive Digital Learning Monitoring and Evaluation System to track and optimize digital tool usage. This system should integrate with the existing Learning Management System to automatically collect data on digital tool usage patterns, allowing for real-time identification of students with low engagement who might be at academic risk.

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