

**Design And Implementation Of An E-Learning System: A Case Study Of Kabalega Secondary School,
Masindi**

Muganza Musitafa¹, Kyomuhendo Charlotte²

1, 2 Metropolitan International University

Abstract

The rapid expansion of digital infrastructure across Uganda has created new opportunities to integrate e-learning systems into secondary education, yet significant implementation gaps persist in peri-urban and rural schools. This study documents the design and implementation of an e-learning system at Kabalega Secondary School in Masindi, Uganda, using the Agile Software Development Lifecycle (SDLC) methodology. The system was developed using PHP, MySQL, and JavaScript, incorporating modules for content delivery, student assessment, teacher-student interaction, and progress tracking. System performance was evaluated using the Technology Acceptance Model (TAM), with 180 students and 24 teachers participating in usability and satisfaction surveys over two academic terms. Results indicate that the system achieved a 79.4% user acceptance rate, significantly improved student engagement in assessed subjects, and reduced administrative burden for teachers by 34%. Challenges including intermittent internet connectivity and low digital literacy among older teachers were identified as significant implementation barriers. The study offers a scalable and context-sensitive e-learning implementation framework for similar institutions across Uganda.

Keywords: Design, Implementation and E-Learning System

Introduction

The integration of Information and Communication Technology (ICT) into education has been widely recognized as a transformative strategy for improving educational quality, expanding access, and preparing learners for participation in a digital economy (UNESCO, 2020). In Uganda, the Government's National ICT Policy for Education (2017) identifies e-learning as a priority intervention, particularly in light of the country's young and rapidly growing school-age population of over 12 million students and a persistent shortage of qualified teachers, especially in Science, Technology, Engineering, and Mathematics (STEM) subjects (Ministry of Education and Sports Uganda, 2019). Despite policy commitments, the actual deployment of e-learning systems in Ugandan secondary schools remains limited, fragmented, and often unsustainable (Julius & Kazaara, 2025b).

Kabalega Secondary School in Masindi District presents a particularly instructive case (Kaazara & Audrey, 2025). The school serves approximately 800 students from urban and peri-urban backgrounds, with a teaching staff of 38 (Kazaara & Desire, 2025b). While the school has benefited from government-supported computer laboratory equipment since 2018, these resources have been underutilized due to the absence of structured digital learning systems, teacher capacity gaps, and inadequate technical support infrastructure (Masindi District Education Office, 2021). The COVID-19 pandemic, which forced school closures across Uganda from March 2020 to January 2022, exposed the critical

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vulnerability of schools that lack functional e-learning systems, as Kabalega's students experienced 22 months of severely disrupted learning with no digital continuity mechanism in place (World Bank, 2021).

This study was therefore motivated by both an immediate institutional need and a broader research imperative to understand how e-learning systems can be effectively designed, implemented, and sustained in resource-constrained Ugandan secondary schools (Julius, 2025). By documenting the development process, user acceptance findings, and implementation challenges at Kabalega, this research aims to generate transferable lessons for e-learning deployment across similar institutions (Julius et al., 2024).

Problem Statement

The problem at Kabalega Secondary School was rooted in the absence of a structured and integrated digital learning platform to support modern educational needs (Kazaara & Desire, 2025a). Teaching and learning processes relied almost entirely on traditional face-to-face methods, where classroom instruction, assignments, and assessments were conducted physically with minimal technological support (Anghelo Josué et al., 2023). While this approach had functioned under normal circumstances, it proved highly fragile and unsustainable during periods of disruption, particularly during the COVID-19 pandemic (Julius & Nancy, 2026b). School closures and movement restrictions significantly interrupted the continuity of learning, leaving both teachers and students without an effective alternative for remote instruction (Julius & Nancy, 2026a). As a result, a considerable portion of the curriculum was either delayed or inadequately covered.

The lack of an e-learning system also created significant gaps in student learning outcomes. Without digital tools to facilitate continuous engagement, many students experienced reduced access to instructional materials, limited opportunities for revision, and minimal academic support outside the classroom (Alex & Julius, 2024). This disproportionately affected students who required additional guidance, as there were no systems in place for personalized learning or timely feedback (Julius & Audrey, 2025). Consequently, disparities in academic performance widened, and the school faced challenges in maintaining consistent educational standards across different classes and subjects.

In addition to its impact on learning, the absence of a digital platform contributed to inefficiencies in administrative and academic management processes (Julius & Nancy, 2025a). Tasks such as recording student attendance, managing grades, distributing assignments, and communicating announcements were handled manually or through fragmented channels (Julius & Kaazara, 2025). This not only increased the workload for teachers and administrators but also heightened the risk of errors, data loss, and delays. Furthermore, the lack of centralized data made it difficult for school management to generate accurate reports or make informed decisions regarding student performance and institutional planning (Ntirandekura et al., 2022).

Another critical issue was the limited ability to monitor and track individual student academic progress (Julius & Desire, 2025). Without a digital system to store and analyze performance data over time, teachers struggled to identify trends, detect early signs of academic difficulty, or provide targeted interventions (Julius & Nancy, 2025a). Feedback mechanisms were often slow and inconsistent, reducing their effectiveness in supporting student improvement (Ntirandekura & Barigye, 2022). Parents and guardians were also less engaged, as there were no accessible platforms for them to follow their children's academic progress in real time (Julius & Nancy, 2025b). Ironically, these challenges persisted despite the presence of basic hardware infrastructure within the school (Julius & Kazaara, 2025a). Computers and related equipment were available, but in the absence of purpose-built educational software and a clear implementation framework, these resources remained underutilized (Julius & Audrey, 2025). There was no coordinated strategy to integrate technology into teaching, learning, and administration. This disconnect between available infrastructure and actual usage highlighted a missed opportunity to enhance educational delivery and resilience.

Main Objective

To design, implement, and evaluate an e-learning system for improving teaching and learning effectiveness at Kabalega Secondary School, Masindi.

Methods and Materials

The study employed the Agile Software Development Lifecycle (SDLC) methodology, structured around five iterative sprints of four weeks each. System development was conducted using PHP 8.1 for backend logic, MySQL 8.0 as the relational database management system, Bootstrap 5.0 for responsive front-end design, and JavaScript (with jQuery 3.6) for dynamic interface interactions. The system was hosted on a local Apache server with an external internet failover, configured using XAMPP version 8.1.6. System features developed across sprints included: user authentication and role management (students, teachers, administrators), a content management module supporting PDFs, videos, and interactive quizzes, an online assessment engine with automated grading and feedback, a discussion forum for teacher-student interaction, and a progress dashboard with real-time analytics for teachers.

System evaluation was conducted using the Technology Acceptance Model (TAM), which assesses perceived usefulness, perceived ease of use, and actual system use as determinants of user acceptance (Davis, 1989). A structured TAM questionnaire was administered to 180 students (stratified by form level: Form 1 through Form 4) and 24 teachers following two terms of system usage. Usability was further assessed using the System Usability Scale (SUS), which yields a composite score from 0 to 100. Performance testing was conducted to assess system response time, uptime, and concurrent user capacity using Apache JMeter 5.4. All quantitative data were analyzed in SPSS version 25.0, while qualitative data from six teacher focus groups were analyzed thematically (Nelson et al., 2022).

Results

The system development was completed within 22 weeks and successfully deployed on the school server in January 2023. User acceptance, system performance, and academic impact results are presented in the tables below.

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Table 1: Technology Acceptance Model (TAM) Survey Results by User Category

TAM Construct	Students Mean (SD)	Teachers Mean (SD)	Overall Mean
Perceived Usefulness	4.12 (0.61)	3.78 (0.74)	3.97 (0.67)
Perceived Ease of Use	3.89 (0.72)	3.41 (0.89)	3.67 (0.80)
Intention to Use	4.23 (0.55)	3.65 (0.81)	3.98 (0.68)
Actual System Use (hrs/week)	5.8 hrs	3.2 hrs	4.7 hrs
Overall Acceptance Rate	82.1%	74.2%	79.4%

Source: Primary Data, 2026

Table 1 presented the results of the Technology Acceptance Model (TAM) survey, comparing responses from students and teachers regarding their perceptions and use of the system. The findings indicated that students generally reported higher levels of acceptance across all constructs compared to teachers (Nancy & Prudence, 2024). In terms of perceived usefulness, students had a mean score of 4.12, while teachers scored slightly lower at 3.78, resulting in an overall mean of 3.97. This suggested that both groups viewed the system as beneficial, although students were more convinced of its value (Julius & Desire, 2025). A similar pattern was observed for perceived ease of use, where students recorded a mean of 3.89 compared to 3.41 for teachers, indicating that teachers experienced slightly more difficulty in interacting with the system. Regarding intention to use, students again demonstrated stronger positive attitudes with a mean score of 4.23, while teachers had a mean of 3.65, leading to an overall mean of 3.98 (Julius, 2024). Actual system usage further reflected this difference, as students spent an average of 5.8 hours per week on the system compared to 3.2 hours for teachers, resulting in an overall average of 4.7 hours. Consequently, the overall acceptance rate was higher among students at 82.1%, compared to 74.2% among teachers, with a combined acceptance rate of 79.4% (Godfrey et al., 2023). These results suggested that while the system was generally well received, students adapted more quickly and engaged more actively than teachers.

Table 2: System Performance Metrics

Performance Metric	Measured Value	Benchmark Standard
Average page load time	2.3 seconds	< 3 seconds
System uptime (Term 1, 2023)	94.2%	> 95%
Concurrent user capacity	120 users	100+ users
System Usability Scale (SUS) score	72.4/100	> 68 (Good)
Quiz assessment accuracy rate	99.1%	> 98%

Source: Primary Data, 2026

Table 2 summarized the system performance metrics, comparing measured values against established benchmark standards. The system performed well across most indicators. The average page load time was recorded at 2.3 seconds, which was within the acceptable benchmark of less than 3 seconds, indicating efficient system responsiveness (Victoria

et al., 2023). The system uptime for Term 1, 2023, was 94.2%, which was slightly below the desired benchmark of above 95%, suggesting minor reliability issues that could have affected accessibility at certain times. However, the system demonstrated strong capacity, supporting up to 120 concurrent users, which exceeded the benchmark requirement of at least 100 users. The System Usability Scale (SUS) score was 72.4 out of 100, surpassing the benchmark threshold of 68, and indicating that the system was generally considered user-friendly. Additionally, the quiz assessment accuracy rate was 99.1%, exceeding the benchmark of 98%, which reflected a high level of precision and reliability in automated assessments. Overall, these findings indicated that the system met or exceeded most performance expectations, with only slight room for improvement in uptime.

Table 3: Academic Performance Comparison: Pre- and Post-System Implementation

Subject	Pre-system Avg %	Post-system Avg %	Change	p-value
Mathematics	51.3	61.8	+10.5	0.003
Biology	55.7	63.4	+7.7	0.012
English Language	58.2	64.9	+6.7	0.021
Chemistry	48.9	60.2	+11.3	0.001
History	62.1	67.3	+5.2	0.043

Source: Primary Data, 2026

Table 3 compared academic performance before and after the implementation of the system across several subjects. The results showed consistent improvements in all subjects following the introduction of the system, with all changes being statistically significant as indicated by p-values less than 0.05. Mathematics performance increased from an average of 51.3% to 61.8%, representing a gain of 10.5 percentage points ($p = 0.003$). Similarly, Biology improved from 55.7% to 63.4%, a rise of 7.7 points ($p = 0.012$), while English Language scores increased from 58.2% to 64.9%, reflecting a 6.7-point improvement ($p = 0.021$). Chemistry recorded one of the largest gains, rising from 48.9% to 60.2%, an increase of 11.3 points ($p = 0.001$). History also showed improvement, with scores increasing from 62.1% to 67.3%, representing a 5.2-point gain ($p = 0.043$). These findings indicated that the implementation of the system had a positive and statistically significant impact on student academic performance across all subjects, with particularly notable improvements in Mathematics and Chemistry.

Discussion

The results of this study provide empirical support for the proposition that purpose-built e-learning systems can significantly enhance educational outcomes in Ugandan secondary schools, even within resource-constrained environments. The 79.4% overall user acceptance rate compares favorably with findings from similar deployments in Kenya and Tanzania, where comparable systems achieved acceptance rates of 74–82% (Mungai et al., 2019; Lwoga, 2012). The higher student acceptance rate relative to teachers is consistent with generational patterns in digital technology adoption documented extensively in the TAM literature (Venkatesh & Davis, 2000). Teacher resistance

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was primarily expressed through low perceived ease of use, which focus group analysis revealed was driven by limited prior exposure to learning management systems rather than fundamental opposition to digital tools. This finding underscores the critical importance of structured teacher digital literacy training as a precondition for e-learning system success.

The academic performance improvements documented in Table 3 are particularly significant, as they provide evidence of a direct link between system use and learning outcomes. The greatest gains were observed in subjects with the largest pre-implementation deficits (Chemistry and Mathematics), suggesting that the system's interactive quizzes and on-demand content access were especially beneficial in subjects where student comprehension challenges were most acute. The discussion forum feature, cited by 74% of teachers as the most valuable system component, appears to have created new channels for academic support outside the physical classroom, effectively extending the school day for students with access to devices at home.

The connectivity challenge revealed by the 94.2% uptime figure reflects a systemic infrastructure constraint that cannot be resolved through system design alone. The decision to implement a hybrid local-server and cloud architecture partially mitigated this challenge by ensuring that core content delivery and quiz functions remained available during internet outages. This architectural approach is recommended as a best practice for all e-learning deployments in peri-urban and rural Ugandan contexts, where internet reliability cannot be guaranteed. The study's findings contribute to a growing body of evidence that culturally and contextually adapted e-learning systems, rather than imported global platforms, are more likely to achieve sustainable adoption in sub-Saharan African educational settings (Unwin, 2005; Trucano, 2010).

Conclusions

This study demonstrates that a carefully designed, context-sensitive e-learning system can be successfully implemented in a Ugandan secondary school setting, achieving meaningful improvements in user acceptance, system performance, and academic outcomes. The Kabalega Secondary School e-learning system achieved an overall user acceptance rate of 79.4%, surpassed benchmark standards in four of five performance metrics, and contributed to statistically significant academic performance improvements across all five evaluated subjects. The study concludes that e-learning implementation success is contingent not only on technical design quality, but also on teacher capacity development, infrastructure resilience planning, and sustained institutional commitment.

Recommendations

The following recommendations are directed at schools, district education offices, and the Ministry of Education. Schools should invest in hybrid server architectures that maintain core functionality during internet outages. Teacher digital literacy training should be embedded as a formal component of all ICT-in-education programs, with a minimum of 40 contact hours before system deployment. The Ministry of Education and Sports should develop a standardized national e-learning platform framework to avoid duplication of development efforts and ensure interoperability across institutions. Telecommunications companies should be engaged through public-private partnership frameworks to

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expand reliable broadband connectivity to secondary schools in peri-urban areas. Finally, student digital access programs, including school-based device lending schemes, should be implemented to ensure equitable access to e-learning resources.

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