Effectiveness of Blended Learning on Academic Performance of University Students in Rwanda

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Abstract: Technology integration has transformed higher education globally, with blended learning emerging as a strategic response to educational challenges in Rwanda and East Africa. Despite international evidence supporting its effectiveness, research on blended learning impact within Rwandan higher education remains limited. This study investigated blended learning effectiveness on academic performance among Rwandan university students. A quasi-experimental design involved 108 third-year students randomly assigned to experimental (blended learning, n=54) or control (traditional instruction, n = 54) groups with balanced gender representation (27 males, 27 females per group). Conducted from January through March 2025, the study administered pre-test and post-test achievement tests. Two-way ANCOVA using SPSS version 27 analysed data, controlling for pre-test scores, with eta-squared (η^2) calculating effect sizes. Blended learning students significantly outperformed traditional instruction students (adjusted means: 18.13 vs. 15.78, F (1,103) =21.004, p<.001, η^2 =.169), with instructional method explaining 16.9% of achievement variance. A significant gender effect favoured males (F (1,103) = 4.628, p=.034, η^2=.043) across both conditions. Critically, no significant interaction between method and gender emerged (F (1,103) =3.479, p=.065, η^2=.033), demonstrating equal benefits for both genders. Blended learning significantly enhances academic performance in Rwandan higher education while providing equitable learning experiences across genders. Findings support strategic institutional investment in blended learning infrastructure, faculty development, and quality assurance mechanisms to optimize educational outcomes in Rwanda's evolving higher education landscape.

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1. Introduction

The integration of technology into higher education has fundamentally transformed pedagogical practices worldwide over the past decade. Educational technology applications have progressed from basic computer-assisted instruction to comprehensive Internet-based learning platforms, ultimately giving rise to blended learning a pedagogical approach that strategically combines face-to-face classroom instruction with digital learning tools to optimize content delivery and student engagement. While educators universally recognize the importance of adapting curricula for the digital era, consensus remains elusive regarding the appropriate scope and implementation strategies for these modifications. In developed nations, adaptation to digital learning environments is considered essential for sustained educational advancement, while stakeholders across educational systems increasingly

advocate for equipping learners with foundational digital competencies necessary to navigate an increasingly technology-dependent world (Bani Hamad, 2011).

Within the African context, and specifically in Rwanda and the broader East African region, blended learning has emerged as a strategic response to persistent educational challenges including limited access to quality instruction, overcrowded learning environments, and escalating demand for flexible educational opportunities. This approach enables diverse learner populations including traditional students, working professionals, and adult learners to pursue education without abandoning existing personal and professional commitments. Research demonstrates that blended learning enhances learning effectiveness, reduces instructional time requirements and associated costs, facilitates access to current information resources, supports collaborative discussions and interactive engagement, and integrates multimedia elements such as simulations, animations, and practical exercises into the learning experience (Al-Shunnaq & Bani Domi, 2010).

Blended learning synthesizes the advantages of electronic learning platforms with the benefits of traditional classroom instruction to optimize educational outcomes (Freihat, 2004; Al-Rimawi, 2016). This approach promotes meaningful interaction among instructors, learners, and educational content while supporting individualized, learner-centered pedagogical practices (Salamah, 2005). Various implementation models including skill-focused, competency-driven, and efficiency-oriented approaches facilitate interaction, provide continuous feedback, and support comprehensive competency development (Al-Faqqi, 2011). Successful implementation requires careful consideration of content selection, integration with real-world applications, diverse instructional strategies, and alignment with curriculum objectives (Al-Rimawi, 2014). However, implementation challenges such as limited digital literacy among stakeholders, inequitable access to technological devices and reliable internet connectivity, and insufficient numbers of qualified instructional personnel may impede successful adoption, underscoring the necessity for strategic planning and robust institutional support systems.

Empirical evidence from international and regional studies supports the effectiveness of blended learning approaches. Research conducted across the Middle East and North Africa demonstrates improvements in academic achievement, knowledge retention, and student attitudes compared to conventional instructional methods (Maccoun, 2016; Al-Rimawi, 2014; Shahin, 2008). Similarly, African research highlights comparable benefits in skill development and learner engagement (Al-Hassan,

2013; Al-Ajab, 2006). Despite this growing body of evidence, research examining blended learning within Rwandan higher education remains limited, particularly concerning its impact on university-level academic performance. This study addresses this research gap by investigating how blended learning influences academic achievement among university students in Rwanda, offering valuable insights for policymakers, educational administrators, and faculty members seeking to enhance teaching effectiveness and learning outcomes in higher education institutions.

1.1 Problem Statement

Despite growing global evidence supporting the effectiveness of blended learning, Rwandan higher education institutions continue to face significant challenges in delivering quality education to expanding student populations amid constrained resources (Hitiyaremye, 2025; INHEA, 2024). Traditional instructional methods often fail to accommodate diverse learning needs or provide flexible access to educational opportunities (Bonk & Graham, 2012; Cao, 2023). While blended learning offers a promising pedagogical solution, empirical research on its impact within the Rwandan context remains limited, restricting evidence-based policy formulation and institutional investment (Harper et al., 2024; Liu et al., 2024). This study seeks to fill this critical gap by systematically investigating whether blended learning approaches lead to measurable improvements in academic performance compared to traditional instruction among university students in Rwanda.

1.2 Research Objective

The objective of this study is to examine the effectiveness of blended learning in enhancing the academic performance of university students in Rwanda.

2. Literature Review

Blended learning is grounded in constructivist learning theory, which emphasizes that learners actively construct knowledge through engagement with content, peers, and instructors, rather than passively receiving information (Tam, 2000). This aligns with blended environments that integrate face-to-face instruction with digital resources, supporting collaborative activities, self-paced modules, and instructor-guided discussions (Bonk & Graham, 2012). Constructivist principles are operationalized in blended learning through asynchronous reflection, synchronous dialogue and problem-solving and multimedia resources that accommodate diverse learning preferences, promoting deeper understanding and meaningful knowledge

construction (Al-Faqqi, 2011; Freihat, 2004). Engagement theory further explains blended learning's effectiveness, emphasizing creative, collaborative, and authentic activities that enhance temporal and cognitive engagement through interactive tools, real-time feedback, and multimedia content (Kearsley & Shneiderman, 1998; Liu et al., 2024; Cao, 2023; Al-Shunnaq & Bani Domi, 2010). The Technology Acceptance Model (TAM) highlights that perceived usefulness and ease of use influence adoption and learning outcomes, while institutional support in the form of reliable infrastructure, technical assistance, and faculty training strengthens technology acceptance and effective implementation (Davis, 1989; Alenazi, 2023; Hitiyaremye, 2025).

Empirical evidence demonstrates that blended learning significantly enhances academic performance, attitudes, and engagement across diverse international contexts, including Canada, Spain, the United States, and China (Cao, 2023; Cortizo et al., 2010; Baepler et al., 2014; Liu et al., 2024). Studies indicate that benefits extend beyond knowledge acquisition to include intrinsic motivation, emotional engagement, and psychological capital, supporting long-term academic success. In Africa, blended learning addresses challenges such as limited access, overcrowded classrooms, and inadequate infrastructure, expanding opportunities to remote and underserved populations (Hitiyaremye, 2025). Initiatives like the Partnership for Enhanced and Blended Learning (PEBL) West Africa illustrate efforts to create quality-assured, credit-bearing courses through regional and international collaboration (Newman, 2022). In Rwanda, government strategies such as the National Strategy for Transformation (NST1) and the USAID-funded Rwanda Education Commons (REC) have promoted technology integration, but higher education still faces rapid enrolment growth, resource constraints, and limited research on effective pedagogical approaches, highlighting the need for systematic evaluation of blended learning outcomes (INHEA, 2024; Wikipedia, 2025; Hitiyaremye, 2025).

Gender differences in academic performance are widely observed, with males typically outperforming females in STEM subjects and females excelling in language arts, influenced by socio-cultural expectations, self-efficacy, classroom participation, and institutional environments (Stoet & Geary, 2018; Voyer & Voyer, 2014; Viviers et al., 2023; Liu et al., 2024; Eddy et al., 2015; Legewie & DiPrete, 2012). In African contexts, female students face additional challenges such as patriarchal attitudes, lack of role models, and unsafe campus environments (Wrigley-Asante et al., 2023; Geremow et al., 2024; Tiruneh & Philipos, 2014). While well-designed blended learning can provide equitable educational experiences, disparities in digital literacy and technology access may disadvantage female students in resource-constrained settings (Harper et al., 2024; Hitiyaremye, 2025). Despite global evidence supporting blended learning, research gaps persist in African higher education, including limited studies on Rwandan universities, gender equity outcomes, long-term learning effects, cost-effectiveness, and mechanisms driving academic improvement, which this study seeks to address.

3. Methodology

This study employed a quasi-experimental design combining quantitative and qualitative approaches to examine the effectiveness of blended learning on academic performance among Rwandan university students. Conducted from January to March 2025, the design enabled measurement of learning outcomes while capturing contextual insights into students' experiences. The target population consisted of third-year students from two universities equipped for blended learning, with 108 participants randomly selected and evenly assigned to experimental (blended learning) and control (traditional instruction) groups, maintaining equal gender representation.

Data collection incorporated multiple instruments to ensure comprehensive assessment. Academic performance was measured using pre- and post-tests covering relevant course content, while structured questionnaires captured students' perceptions on a five-point Likert scale. Qualitative insights were obtained through document reviews and semi-structured interviews, providing nuanced perspectives on blended learning experiences. The experimental group engaged with a combination of technology-enhanced presentations, multimedia resources, synchronous sessions, and asynchronous activities, while the control group received conventional lecture-based instruction.

Data analysis integrated quantitative and qualitative methods. Descriptive and inferential statistics, including two-way ANCOVA, compared academic performance across groups, with effect sizes (η^2) quantifying treatment impact. Qualitative data were thematically analysed to enrich understanding of student experiences. Ethical procedures included institutional approval, informed consent, voluntary participation, and assurance of confidentiality and anonymity. Together, these methodological approaches provided robust evidence on the effectiveness of blended learning and its impact on students' academic performance and learning experiences.

4. Results and Discussion

4.1 Academic Performance by Instructional Method and Gender

To address the research question examining whether mean achievement scores differed based on instructional method and gender, descriptive statistics were first calculated. Table 2 presents the means and standard deviations for both pre-test and post-test achievement scores across experimental and control groups, disaggregated by gender.

Table 1: Descriptive Statistics for Achievement Scores by Group and Gender

Gender	Statistics	Pre-test			Post-test		
		Control	Experimental	Total	Control	Experimental	Total
Male	N	27	27	54	27	27	54
	Mean	2.67	2.74	2.70	15.85	19.15	17.50
	SD	1.39	1.16	1.27	3.37	1.06	2.98
Female	N	27	27	54	27	27	54
	Mean	2.56	2.11	2.33	15.70	17.11	16.41
	SD	1.28	1.05	1.18	2.87	2.67	2.83
Total	N	54	54	108	54	54	108
	Mean	2.61	2.43	2.52	15.78	18.13	16.95
	SD	1.32	1.14	1.23	3.10	2.26	2.95

Descriptive analysis revealed clear differences between the experimental and control groups in both pre-test and post-test measures, as well as differences between male and female students. The experimental group showed higher mean post-test scores (M=18.13, SD=2.26) compared to the control group (M=15.78, SD=3.10), representing a mean difference of 2.35 points. Male students demonstrated higher mean post-test scores (M=17.50, SD=2.98) compared to female students (M=16.41, SD=2.83) across both instructional conditions. A two-way ANCOVA was performed to determine the statistical significance of these differences while controlling for pre-test performance.

4.2 Analysis of Covariance Results

Table 3 presents the ANCOVA results examining the effects of instructional method, gender, and their interaction on post-test achievement scores, with pre-test scores serving as the covariate.

Table 2: Two-Way ANCOVA Results for Post-test Achievement Scores

Source	Sum of Squares	df	Mean Square	F	p	η²
Pre-test (Covariate)	0.330	1	0.330	0.047	.829	0.000
Instructional Method	147.393	1	147.393	21.004	<.001*	.169
Gender	32.474	1	32.474	4.628	.034*	.043
Method × Gender	24.411	1	24.411	3.479	.065	.033
Error	722.781	103	7.017			
Total	927.389	107				

*p < .05

The ANCOVA results revealed a statistically significant main effect for instructional method, $F_{(1,103)} = 21.004$, $p<.001$, $\eta^2=.169$. This indicates that the instructional method accounted for approximately 16.9% of the variance in post-test achievement scores, representing a large effect size according to Cohen's guidelines. A statistically significant main effect was also found for gender, $F_{(1,103)} =4.628$, $p=.034$, $\eta^2=.043$, accounting for approximately 4.3% of variance in achievement, representing a small to medium effect size. The interaction between instructional method and gender was not statistically significant, $F_{(1,103)} =3.479$, $p=.065$, $\eta^2=.033$, indicating that the effect of blended learning on achievement did not differ significantly between male and female students.

4.3 Adjusted Mean Comparisons

To identify the direction of significant effects while controlling for pre-test differences, adjusted means were calculated. Table 3 presents these adjusted post-test means for each instructional group.

Table 3: Adjusted Post-test Means by Instructional Method

Group	Adjusted Mean	Standard Error
Experimental (Blended Learning)	18.13	0.36
Control (Traditional Learning)	15.78	0.36

The adjusted means show that the experimental group (M=18.13, SE=0.36) significantly outperformed the control group (M=15.78, SE=0.36) by 2.35 points on the achievement post-test, demonstrating a meaningful advantage for blended learning instruction. This difference represents approximately a 14.9% improvement in achievement scores for students receiving blended learning compared to traditional instruction. While male students performed significantly better than female students across both instructional conditions, the non-significant interaction effect indicates that blended learning's advantage over traditional instruction was consistent for both genders, with no differential benefit based on gender. Both male and female students benefited equally from the blended learning approach.

4.4 Discussion

This study demonstrates that blended learning significantly improves academic performance among Rwandan university students, accounting for 17% of variance representing a substantial and meaningful effect. Improvements were driven by increased student engagement, flexibility that accommodated diverse learning needs, enhanced comprehension through multimedia resources, and continuous teacher–student interaction combining classroom and digital environments. These findings align with global evidence supporting blended learning and reinforce the need for investment in digital infrastructure and faculty capacity building.

Although male students slightly outperformed females (4.3% variance), blended learning benefited both genders equally, as indicated by a non-significant interaction effect. This outcome is important in a context where digital literacy gaps risk disadvantaging female learners, suggesting that well-designed blended learning can provide equitable opportunities. Nonetheless, the persistent gender gap highlights the need for targeted interventions including inclusive pedagogy, supportive learning environments, and tailored academic support and calls for further research to understand underlying causes within Rwandan higher education.

Effective implementation requires universities to prioritize strong technological infrastructure, comprehensive faculty training, instructional design support, continuous quality assurance, and equity-focused measures such as device loan programs and subsidized internet access. Broader institutional strategies should include clear implementation policies, communities of practice, incentives for innovative teaching, and meaningful student involvement in course design. While the study provides valuable insights, its generalizability is limited by a small sample of universities, short study duration, a narrow disciplinary focus, and constraints of a quasi-experimental design. Future research should expand to more institutions, disciplines, incorporate longitudinal, and mixed-methods approaches, examine varied blended learning models, and explore cost-effectiveness, gender disparities, faculty adoption processes, and scalability to better guide policy and practice in Rwanda.

5. Conclusion and Recommendations

5.1 Conclusion

This study shows that blended learning significantly improves academic performance among Rwandan university students, explaining 17% of outcome variance and resulting in a 14.9% performance advantage over traditional instruction. These gains stem from enhanced engagement, flexibility, multimedia resources, and continuous interaction that strengthen learning processes. While males outperformed females overall, the absence of a significant interaction effect indicates that blended learning benefits both genders equally, though persistent gender gaps highlight the need for targeted support. The findings underscore the importance of investing in reliable technology, faculty training, instructional design, quality assurance, and equity measures to ensure successful implementation. Overall, by combining traditional teaching with digital innovation, blended learning offers Rwandan universities a practical strategy to improve access, enhance engagement, and better prepare students for success in an increasingly digital world.

5.2 Recommendations

Based on the study's findings, Rwandan higher education institutions should invest in robust blended learning infrastructure and provide faculty with professional development in instructional design, technology integration, and online facilitation. Faculty should adopt student-centered approaches, use diverse multimedia resources, maintain regular communication, and implement quality assurance mechanisms, while equity measures like laptop loans, subsidized internet, and flexible scheduling ensure access for all students. Policymakers should support educational technology through funding, national quality frameworks, and partnerships with the private sector and international organizations. Targeted initiatives, including mentorship, gender-sensitive teaching, and academic support, are recommended to address persistent gender performance gaps. Future research should employ multi-institutional, longitudinal, and mixed-methods designs to assess blended learning effectiveness, knowledge retention, career outcomes, and cost-effectiveness, while comparing different models to optimize implementation. These measures collectively aim to enhance educational quality, equity, and student success in Rwanda's higher education system.

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