



# Effect of ICT Tools Integration in Teaching-learning Mathematics on Students' Academic Performance in Upper Secondary Schools of Muhanga District, Rwanda

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**Abstract:** *This research investigates the Effect of integrating ICT tools on students' academic achievement in Mathematics at selected upper secondary schools in Muhanga District, Rwanda. Employing a mixed-methods design, the study targeted a population of 1,268 participants, comprising 1,243 students and 25 teachers, with a final sample of 303 students and 12 teachers drawn from 12 schools. Data were collected through questionnaires, interviews, and a pilot study. The research explored the influence of ICT tools such as online learning platforms and YouTube on students' Mathematics performance during the first term of the 2024–2025 academic year. The findings revealed that ICT integration significantly enhanced students' comprehension, engagement, and academic performance. Chi-square ( $\chi^2$ ) analysis demonstrated a statistically significant effect ( $p = 0.000$ ), while Spearman's correlation coefficient (0.772) indicated a strong positive relationship between ICT utilization and academic outcomes. These results suggest that the deliberate incorporation of ICT tools into Mathematics instruction has the potential to substantially improve teaching and learning processes in Muhanga District. The observed improvement in student participation and understanding highlights the importance of leveraging digital technologies to promote interactive and inclusive learning environments. The study recommends that government authorities invest in ICT infrastructure and teacher training to further improve student performance. Additionally, future research should investigate the challenges teachers encounter in implementing ICT, particularly regarding professional development and technical support.*

**Keywords:** *Integration of ICT, Effect, Academic, Teaching-Learning Mathematics, ICT tools, students' performance, Upper secondary schools.*

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## 1. Introduction

The primary objective of any national education system is to enable learners to attain outcomes that align with the country's developmental aspirations. Education serves as a cornerstone of economic progress, and an educated

population represents a crucial asset for national growth. The foundation of a well-educated society begins with the quality of learning achieved at the primary level (UNESCO, 2007). Establishing an equitable and inclusive society, where every individual has access to learning

opportunities, depends on ensuring quality education for all.

Over the past decade, the global advancement of Information and Communication Technology (ICT) policies has significantly enhanced productivity across multiple sectors, including healthcare, education, environmental management, energy, employment, and social development (United Nations, 2020). Since the 1990s, many governments have adopted ICT in education to expand accessibility and enhance instructional quality. ICT has been recognized as a key instrument in achieving globalization goals (School Net Africa, 2003). The integration of digital technologies in teaching and knowledge acquisition provides learners with improved academic performance and better employment prospects. Consequently, the increasing demand for ICT among students has reinforced the perception of the world as a “global village.”

Across Africa, however, the adoption of ICT in education has been uneven, with substantial disparities among countries. Nations such as South Africa, Kenya, and Rwanda have demonstrated notable progress in integrating ICT into their educational systems, particularly through initiatives designed to strengthen Mathematics instruction. For instance, Rwanda’s One Laptop per Child (OLPC) program aims to equip students with digital devices to enhance learning outcomes, including in Mathematics (MINEDUC, 2018).

The Rwanda’s Vision 2020 and later Vision 2050, which highlight how technology can revolutionize education and raise student achievement, the country has made integrating ICT tools into the classroom a top goal. The efficient use of ICT in classrooms is nevertheless hampered by issues including inadequate infrastructure, a lack of teacher training, and scarce resources, especially in remote districts like Muhanga (Rubagiza & Sutherland, 2011). A review of Muhanga District students’ academic performance in Mathematics revealed comparatively poor performance in previous years (Uwineza, I. et al, 2018). Therefore, it is necessary to address the issue of Mathematics performance.

Consequently, improvements in Mathematics performance have not been uniform across schools within the district. This situation underscores the necessity of conducting an in-depth investigation into the specific impact of ICT tools on Mathematics achievement in upper secondary schools within Muhanga District. Overall, the integration of ICT in Mathematics teaching and learning has been strongly associated with improved student outcomes. Existing evidence suggests that ICT enhances learner engagement, fosters higher-order thinking, supports individualized learning, expands access to educational materials,

strengthens assessment and feedback mechanisms, and promotes collaborative learning environments.

## 1.1 Statement of the Problem

In 2016, the Government of Rwanda introduced a comprehensive curriculum reform aimed at improving the overall quality of education. This reform involved a shift from a knowledge-based curriculum to a Competency-Based Curriculum (CBC), emphasizing the acquisition of skills, attitudes, and values that enable learners to apply knowledge effectively in real-life situations. In conjunction with this transformation, the Government launched the One Laptop per Child (OLPC) initiative, through which Positivo BGH laptops were distributed to secondary school students to enhance their learning experiences and improve academic achievement, particularly in Mathematics.

The integration of Information and Communication Technology (ICT) tools such as online learning platforms, interactive classrooms, internet-based resources, and digital learning systems was envisioned as a strategy to make mathematical concepts more comprehensible, interactive, and engaging for students. This study aims to assess the influence of ICT tools on students’ academic performance in Mathematics. By exploring the relationship between ICT usage, instructional methods, and learner outcomes, the research seeks to identify the challenges hindering effective ICT integration and propose practical solutions for improvement.

The continued low academic performance among students, particularly in Senior Six (S6) national examinations that determine access to tertiary education, underscores the significance of this study. Understanding how ICT contributes to Mathematics achievement will not only help improve instructional practices but also enhance students’ readiness for future academic pursuits and professional careers.

## 1.2 Specific objectives

To achieve the main objective of this study, we considered four specific objectives:

1. To assess the students’ performance in Mathematics about their accessibility and engagement with ICT tools.
2. To examine the competence and training of teachers in using ICT tools for teaching Mathematics.
3. To analyze the effect of tools availability and usage in teaching and learning Mathematics on students’ academic performance.

4. To establish the relationship between the ICT Tools usage in Teaching-Learning Mathematics and the students' academic performance in Mathematics.

### 1.3 Research hypotheses

Null hypothesis ( $H_0$ ): There is no significant relationship between the ICT Tools usage in Teaching-Learning Mathematics and students' academic Performance in upper secondary schools of Muhanga District. Alternative hypothesis ( $H_1$ ): There is a significant relationship between the ICT Tools usage in Teaching-Learning Mathematics and students' academic Performance in upper secondary schools of Muhanga District.

## 2. Literature Review

This section examines relevant research on the use of Information and Communication Technology (ICT) tools in the teaching and learning of Mathematics, as well as their influence on students' academic performance. The integration of ICT in education has been widely acknowledged as a pivotal element in improving instructional quality and learner engagement. In Mathematics education specifically, ICT has the potential to transform conventional pedagogical approaches, making mathematical concepts more understandable, interactive, and engaging for learners. This empirical review synthesizes existing studies on the effects of ICT tool utilization in Mathematics instruction and its impact on the academic achievement of upper secondary school students within Muhanga District.

### 2.1 ICT Tools and Their Role in Enhancing Mathematical Understanding

A variety of ICT tools have been developed to specifically support the teaching and learning of Mathematics. Dynamic geometry software such as GeoGebra and computer algebra systems (CAS) have been shown to deepen students' conceptual understanding of mathematical principles (Setianingsih et al., 2019). For example, GeoGebra's interactive visualization features allow learners to explore mathematical relationships dynamically, thereby enhancing problem-solving skills and conceptual comprehension. Similarly, tools like Symbolab, an interactive problem-solving calculator, enable students to engage with complex trigonometric problems in a hands-on manner, facilitating a stronger grasp of trigonometric concepts (Ndagijimana et al., 2024).

Furthermore, the adoption of interactive whiteboards in Mathematics classrooms has been associated with

increased student motivation and improved learning outcomes. (Mercer, 2014), notes that these tools provide a platform for teachers to present mathematical content visually and interactively, fostering student engagement and comprehension. This finding is particularly significant in the context of Muhanga District, where the incorporation of interactive whiteboards could transform traditional Mathematics classrooms into more dynamic and participatory learning environments.

### 2.2 ICT Usage in Mathematics Education

Research consistently demonstrates that ICT integration has a positive impact on students' academic performance by making learning more interactive, accessible, and aligned with the principles of constructivism, which emphasize active and meaningful learning (Coelho et al., 2024). ICT facilitates collaborative learning environments that promote interaction, cooperation, and experiential learning principles that are consistent with constructionist theory (Devajit et al, 2020).

The research by (Ndagijimana et al., 2024) found that the use of the Symbolab calculator significantly improved pre-service primary teachers' conceptual understanding of trigonometry through a community of inquiry approach, which fosters active participation, peer dialogue, and collaborative problem-solving. Likewise, (Munyaruhengeri et al., 2023) reported that GeoGebra enhanced students' spatial reasoning and problem-solving skills while providing an engaging, interactive platform that allows real-time manipulation of mathematical objects.

### 2.3 ICT and Students' Academic Performance in Mathematics

The integration of ICT in Mathematics instruction has been found to increase student engagement and create enjoyable learning experiences by offering diverse methods of exploring similar concepts. It also provides opportunities for learners to develop creativity, communication, and critical thinking skills (Devajit et al, 2020). The ICT is essential to upgrading and changing the educational system and teaching methodologies. According to (Uworwabayeho, 2016), teacher training in ICT should go beyond merely acquainting educators with new technologies. The research conducted by (Robova, 2014) demonstrated that the incorporation of ICT tools in classrooms can significantly enhance students' comprehension of mathematical ideas and their ability to solve problems. The interactive and exploratory nature of

ICT encourages deeper engagement with content, leading to better knowledge retention and application.

Similarly, (Ndagijimana et al. , 2025) highlighted the positive influence of PhET simulations on Rwandan students' understanding of scientific concepts such as chemical reactions, acids, and bases. By using these simulations, learners were able to visualize abstract scientific phenomena, thereby improving their conceptual grasp and analytical abilities. This evidence suggests that ICT tools have the potential to enhance academic performance across multiple STEM disciplines, including Mathematics.

However, the effectiveness of ICT integration largely depends on how these technologies are implemented in teaching. Aligning ICT tools with educational objectives is therefore essential for maximizing their impact. As (Munyaruhengeri et al. , 2023) assert, when effectively integrated, tools such as GeoGebra not only enhance students' spatial reasoning and problem-solving skills but also foster interactive and meaningful engagement with mathematical content.

## **3. Methodology**

### **3.1 Research Design**

This study adopted a mixed-methods research design to examine the effect of Information and Communication Technology (ICT) tools on students' academic achievement in Mathematics. The quantitative component utilized a comparative design, analyzing standardized test results from both experimental and control groups. The control group was instructed through conventional teaching methods, whereas the experimental group incorporated ICT tools such as online learning platforms, digital resources, and educational applications.

The qualitative component involved semi-structured interviews with Mathematics teachers from both groups to gather their insights, experiences, and perceptions regarding the integration of ICT in the classroom. By combining quantitative and qualitative approaches, the study provided a comprehensive understanding of how ICT tools influence students' academic performance. In this research, ICT tool usage served as the independent variable, while students' performance in Mathematics was treated as the dependent variable. This integrated design allowed for a thorough evaluation of ICT's role in enhancing Mathematics education within Muhanga District.

### **3.2 Population**

The target population comprised 1,268 participants drawn from twelve upper secondary schools in Muhanga District. This included 1,243 students and 25 Mathematics teachers. As the research focused on science-oriented education, particularly Mathematics, this population was considered suitable for examining the extent and effectiveness of ICT tool integration in the subject area.

### **3.3 Sample and Sampling Procedures**

The sampling process followed a multi-stage procedure. Initially, a comprehensive list of all upper secondary schools in the district was obtained from the District Education Office. From this list, one school per sector was purposively selected to ensure fair geographical representation. Within each selected school, Mathematics classes were identified, and students were randomly chosen across different grade levels to capture varying academic stages.

Similarly, Mathematics teachers actively involved in classroom instruction were randomly selected to ensure that the sample reflected educators with direct teaching experience in Mathematics. This combination of purposive and random sampling ensured that both students and teachers were adequately represented, thereby increasing the generalizability and reliability of the study findings.

### **3.4 Research Instruments**

Two primary research instruments were utilized: structured questionnaires for students and an interview guide for Mathematics teachers. The use of questionnaires was advantageous for collecting quantitative data efficiently from a large number of participants within a short time frame. The instrument was designed to obtain detailed information on students' perceptions, frequency of ICT tool usage, and their academic performance.

For teachers, semi-structured interviews provided qualitative insights into their experiences, attitudes, and challenges regarding ICT integration in Mathematics instruction. Together, these instruments facilitated comprehensive data collection, enabling the study to capture both numerical trends and contextual understandings relevant to the research objectives.

### 3.5 Data Analysis

The collected data were analyzed using both quantitative and qualitative techniques. Descriptive statistics were employed to summarize and present data related to ICT usage and students' performance in Mathematics. Quantitative data obtained from questionnaires were analyzed using IBM SPSS Statistics (version 21), employing descriptive and inferential statistical methods such as frequencies, percentages, Chi-square tests, Analysis of Variance (ANOVA), and Spearman's rank correlation to identify relationships and differences between control and experimental groups.

Qualitative data gathered from interviews and classroom observations were analyzed using thematic analysis. This approach allowed for the identification of recurring themes, patterns, and insights concerning teachers' experiences with ICT integration. The combination of these analytical methods provided a balanced and in-depth understanding of how ICT tools affect Mathematics learning outcomes in Muhanga District.

## 4. Results and Discussion

Data collection was guided by the study's specific research objectives and questions. The analysis was conducted using the Statistical Package for the Social Sciences (SPSS), version 21. A total of 315 questionnaires were distributed, comprising responses from 303 students and 12 Mathematics teachers.

### 4.1 The Results

The results of this research are presented in relation to the stated objectives and research questions. Each objective is systematically addressed through detailed data analysis and interpretation to ensure that the findings directly correspond to the study's aims. This section provides a comprehensive overview of how the use of ICT tools influences various dimensions of Mathematics education, including student engagement, accessibility, and performance outcomes.

#### 4.1.1 Students' Performance in Mathematics in Relation to Their Accessibility and Engagement with ICT Tools

This subsection compares the academic performance of upper secondary school students in Muhanga District who are taught Mathematics using ICT tools with those who are instructed through traditional teaching methods. The comparison seeks to determine the extent to which access to and engagement with ICT tools affect students' academic achievement in Mathematics.

By examining differences in performance between the two groups, the study provides insights into the effectiveness of ICT-supported instructional strategies. The results contribute to understanding how ICT integration enhances or constrains Mathematics learning in the district. Ultimately, these findings offer valuable implications for policymakers, educators, and stakeholders seeking to improve Mathematics outcomes and strengthen ICT integration in upper secondary education within Muhanga District.

**Table 1: Comparison of performance between the schools that taught Mathematics with ICT tools and without it**

			School category	
			Teaching without using ICT tools	Teaching with ICT tools
Students' Performance	Fail (Below 50%)	Count	82	16
		%	60.3%	9.6%
	Satisfactory (50%-59%)	Count	39	32
		%	28.7%	19.2%
	Good (60%-69%)	Count	7	57
		%	5.1%	34.0%
	Very good (70%-79%)	Count	6	37
		%	4.4%	22.2%
	Excellent (Above 80%)	Count	2	25
		%	1.5%	15.0%

The findings reveal a notable improvement in academic achievement among students attending schools that integrate ICT tools into Mathematics instruction. In the “Good” (60%–69%) performance category, 34% of students from ICT-supported classrooms achieved this level, compared to only 5.1% of their counterparts in non-ICT schools. Likewise, within the “Very Good” (70%–79%) category, 22.2% of students in ICT-integrated schools attained higher scores, whereas only 4.4% of students from schools without ICT reached this performance range. These results clearly indicate that the incorporation of ICT tools in Mathematics teaching has a significant positive impact on students’ academic outcomes. The use of technology not only enhances comprehension and engagement but also contributes to a marked reduction in failure rates and an increase in the proportion of students attaining higher achievement levels.

#### **4.1.2 The competence and training of teachers in using ICT tools for teaching Mathematics**

The analysis of teacher competence and training in using ICT tools for teaching Mathematics reveals key differences between schools with and without ICT integration. In ICT-equipped schools, 58% of teachers reported challenges such as limited devices, technical issues, and unreliable internet. In contrast, teachers in non-ICT schools faced even greater difficulties due to a total lack of digital tools, relying on traditional teaching methods. While 50% of teachers in ICT-integrated schools had received some ICT training, many still struggled to apply it effectively. Only one teacher in non-ICT schools had received any relevant training. Despite some access, 75% of all teachers expressed a strong need for comprehensive professional development in ICT use.

Administrative support also plays a critical role. In ICT-integrated schools, 75% of teachers reported receiving administrative support through access to resources and ICT guidance. However, in non-ICT schools, all teachers reported a complete lack of such support, which they identified as a major barrier to ICT adoption. Overall, the study highlights significant challenges in resource availability, teacher training, and institutional backing. Schools with stronger support systems and training opportunities are more successful in implementing ICT, but additional investment is needed to ensure all educators can fully utilize technology to enhance Mathematics instruction.

#### **4.1.3 The effect of ICT tools availability and usage in teaching - learning Mathematics on students’ academic performance**

This section explores the influence of ICT tool availability and utilization on students’ academic performance in Mathematics. As Mathematics is widely regarded as a challenging subject, the integration of ICT tools such as educational software, online learning resources, and interactive digital platforms can play a transformative role in enhancing students’ comprehension of mathematical concepts and improving their problem-solving abilities.

To assess this effect, data were analyzed using a coding framework based on selected measurement indicators. The responses were categorized as follows: 1 = Strongly Agree (SA), 2 = Agree (A), 3 = Disagree (D), and 4 = Strongly Disagree (SD). This coding system facilitated systematic analysis of participants’ perceptions regarding how the availability and effective use of ICT tools contribute to improved learning experiences and academic outcomes in Mathematics.

**Table 2: The results on the effect of ICT tools usage and students' academic performance**

	SA n(%)	A n(%)	D n(%)	SD n(%)	N
The use of online platforms in teaching Mathematics influences students' understanding of the subject in the classroom.	116 38.3%	124 40.9%	45 14.9%	18 5.9%	303
The ICT makes Mathematics lessons more engaging and enjoyable for students.	111 36.6%	121 39.9%	51 16.8%	20 6.6%	303
The ICT tools introduce greater diversity in the delivery of Mathematics lessons.	141 46.5%	99 32.7%	42 13.9%	21 6.9%	303
The use of a smart classroom in teaching and learning Mathematics impacts how students understand Mathematical concepts.	166 54.8%	71 23.4%	47 15.5%	19 6.3%	303
The use of the internet in teaching and learning Mathematics aids students in understanding mathematical concepts.	143 47.2%	101 33.3%	49 16.2%	10 3.3%	303
The students' use of computers during Mathematics lessons affects their performance in the subject.	125 41.3%	112 37.0%	45 14.9%	21 6.9%	303
The ICT tools are highly beneficial for students in learning Mathematics.	119 39.3%	98 32.3%	48 15.8%	38 12.5%	303
The teacher's use of social media platforms like YouTube enhances students' understanding and performance in Mathematics lessons.	169 55.8%	101 33.3%	23 7.6%	10 3.3%	303
The ICT tools make learning Mathematics more interesting and engaging for students.	163 53.8%	95 31.4%	31 10.2%	14 4.6%	303

**Source:** Primary data, 2025

The findings presented in Table 2 demonstrate a strongly positive perception of the impact of ICT tools on students' academic performance in Mathematics. A significant majority of respondents strongly agreed or agreed that the use of ICT enhances their understanding of mathematical concepts, increases engagement, and makes learning more enjoyable. Specifically, over half of the participants (54.8%) affirmed that smart classroom technologies significantly improve comprehension of mathematical ideas, while 55.8% strongly agreed that teachers' use of social media platforms such as YouTube contributes to better understanding and performance. Similarly, 53.8% of respondents agreed that ICT tools make Mathematics lessons more engaging and interesting.

These results suggest that ICT integration in Mathematics instruction not only supports deeper conceptual understanding but also promotes learner motivation and participation. The data further indicates that ICT fosters a more dynamic and interactive learning environment, offering diverse methods of presenting and exploring mathematical concepts. Overall, the findings affirm that the availability and effective use of ICT tools play a vital

role in enhancing students' academic outcomes in Mathematics.

#### **4.1.4 The relationship between the ICT Tools usage in Teaching-Learning Mathematics and the students' academic performance of upper secondary schools in Muhanga District**

The relationship between ICT tool usage and students' academic performance in Mathematics was analyzed using cross-tabulation to determine how these tools influence learning outcomes. The results indicate a strong positive relationship between the use of ICT tools in teaching and learning Mathematics and students' academic performance. Specifically, the Spearman's correlation coefficient of determination revealed that 77.2% of the variation in students' Mathematics performance can be attributed to the use of ICT tools in the teaching-learning process. The corresponding p-value was 0.000, which is below the 0.05 significance threshold, indicating that the relationship is statistically significant.

These findings suggest that the independent variable ICT tool usage has a substantial effect on students' academic outcomes in Mathematics. Overall, the analysis confirms a strong association between ICT integration in Mathematics

instruction and enhanced student performance, highlighting the critical role of technology in improving learning outcomes in upper secondary schools within Muhanga District.

**Table 3: The correlation between students' performance in Mathematics and their use of ICT tools**  
**Correlations**

		Performance	Have you learned Mathematics using ICT Tools?
Performance	Pearson Correlation	1	.772**
	Sig. (2-tailed)		.000
	N	303	303
Have you learn Mathematics using ICT Tools?	Pearson Correlation	.772**	1
	Sig. (2-tailed)	.000	
	N	303	303

\*\* . Correlation is significant at the 0.01 level (2-tailed).

The findings indicate that respondents perceive a positive impact of ICT tool usage on both the teaching and learning of Mathematics and on students' academic performance. The results demonstrate a strong positive correlation between the use of ICT tools in Mathematics instruction and students' achievement in the subject. This suggests that Mathematics educators aiming to enhance students' performance should consider incorporating ICT tools into their instructional practices.

## 4.2 Discussion

### 4.2.1 Overview of the study

This study was guided by four specific objectives: to evaluate students' performance in Mathematics in relation to their access to and engagement with ICT tools, to assess teachers' competence and training in using ICT tools for Mathematics instruction, to examine the effect of ICT tool availability and utilization on students' performance, and to explore the relationship between ICT integration and academic outcomes. Data were collected from 12 schools, encompassing 303 students and 12 Mathematics teachers. The analysis, conducted using SPSS, provided insights into the role of ICT tools in enhancing students' performance in Mathematics.

The findings indicate a positive influence of ICT tools on student engagement and understanding of mathematical concepts. Students in schools with ICT integration reported that these tools made learning more engaging, interactive,

and accessible. These results align with (Mercer, 2014), who noted that tools such as interactive whiteboards significantly enhance students' comprehension of mathematical concepts, particularly in areas like limits and continuity. By incorporating ICT tools, teachers are able to accommodate diverse learning styles, enabling students to visualize complex mathematical relationships and deepen their conceptual understanding.

Moreover, (Mayer Richard, 2009) highlights in his Cognitive Theory of Multimedia Learning that learners grasp information better when it is delivered using both words and images. This reinforces the notion that ICT tools improve conceptual comprehension by offering various representations of mathematical concepts. Additionally, the results are backed by (Punam Bhatia, 2021), who claims that incorporating ICT in classrooms fosters active learning and enhances students' problem-solving abilities. Through the use of ICT tools, educators can cater to varied learning preferences, allowing students to see intricate mathematical connections and enhance their conceptual comprehension.

Conversely, students in schools without ICT integration struggled to grasp complex mathematical concepts, highlighting the critical role of ICT in creating a more interactive and stimulating learning environment. These findings are consistent with the work of (Ndagijimana et al. , 2025), who reported that ICT tools such as PhET simulations improved students' understanding of chemical reactions in Rwanda through interactive learning. Similarly, in Mathematics, tools like GeoGebra and

Symbolab calculators provide interactive experiences that enhance comprehension in ways that traditional methods often cannot. These findings are further supported by (UNESCO, 2021), which highlights that lack of infrastructure and teacher preparedness remain major obstacles to effective ICT integration in developing countries.

Indeed, the results of this research strongly mention previous studies indicating that the incorporation of ICT in education positively impacts students' performance in Mathematics by boosting engagement, enhancing conceptual comprehension, and advancing academic success. However, the research also uncovered numerous obstacles that delay the complete achievement of these advantages, including insufficient infrastructure like restricted access to devices and unstable internet connectivity, low digital literacy levels among students and educators. Attacking these issues by enhancing infrastructure, ongoing professional development for educators, and fostering digital skills will be crucial for optimizing the use of ICT tools and achieving improved learning results in Mathematics.

#### **4.2.2 Testing of hypothesis**

Based on the study objectives, the researcher formulated the following hypotheses: The null hypothesis ( $H_0$ ) states that there is no significant relationship between the use of ICT tools and students' academic performance in

Mathematics. In other words, ICT tool usage does not significantly enhance students' understanding or performance in the subject. Conversely, the alternative hypothesis ( $H_1$ ) proposes that a significant positive relationship exists, suggesting that ICT tools such as online learning platforms, smart classrooms, social media, and other educational technologies positively influence students' comprehension and achievement in Mathematics.

To test these hypotheses, a chi-square ( $\chi^2$ ) test was conducted to determine whether the variables are independent. The  $\chi^2$  statistic was calculated using the observed and expected frequencies of the variables and then compared to the critical value obtained from the chi-square distribution table. The decision rule was as follows: if the computed  $\chi^2$  value is equal to or exceeds the tabulated value, the null hypothesis ( $H_0$ ) is rejected, indicating a significant relationship between the variables. If the computed  $\chi^2$  value is lower than the critical value,  $H_0$  is retained, implying no significant association.

This methodology provides an objective assessment of the relationship between ICT tool usage and students' performance in Mathematics. The chi-square test results, presented in Table 4 include correlation coefficients, the computed  $\chi^2$  value, degrees of freedom, and the corresponding p-value, allowing for a clear interpretation of the statistical significance of the relationship under investigation.

**Table 4: The statistical results summary on the effect of ICT tools in teaching and learning process and Students' academic performance in Mathematics**

Variables	Results			
	Correlation	p-value	$\chi^2$	df
The use of online platforms in teaching Mathematics influences students' understanding of the subject in the classroom.	.864**	.000	85.211 <sup>a</sup>	12
The ICT makes Mathematics lessons more engaging and enjoyable for students.	.808**	.000	49.647 <sup>a</sup>	12
The ICT tools introduce greater diversity in the delivery of Mathematics lessons.	.605**	.000	43.802 <sup>b</sup>	12
The use of a smart classroom in teaching and learning Mathematics impacts how students understand mathematical concepts.	.851**	.000	56.376 <sup>b</sup>	12
The use of the internet in teaching and learning Mathematics aids students in understanding mathematical concepts.	.770**	.000	57.383 <sup>a</sup>	12
The students' use of computers during Mathematics lessons affects their performance in the subject.	.843**	.000	70.320 <sup>a</sup>	12
The ICT tools are highly beneficial for students in learning Mathematics.	.810**	.000	82.782 <sup>a</sup>	12
The teacher's use of social media platforms like YouTube enhances students' understanding and performance in Mathematics lessons.	.833**	.000	44.842 <sup>a</sup>	12
The ICT tools make learning Mathematics more interesting and engaging for students.	.853**	.000	84.947 <sup>a</sup>	12

Source: Primary data, 2025

The table presents various variables associated with ICT tool usage in Mathematics instruction, including their correlation coefficients, p-values, and chi-square ( $\chi^2$ ) statistics. The correlation coefficients, ranging from 0.605 to 0.864, indicate a strong positive relationship between the use of ICT tools and students' academic performance in Mathematics. Furthermore, all p-values are below the 0.05 threshold, demonstrating that the results are statistically significant.

These findings suggest that ICT tool usage in teaching and learning significantly influences students' performance in Mathematics. Specifically, the p-values (all .000) indicate that the relationships observed are statistically meaningful. The chi-square values further corroborate this conclusion, confirming that the associations between ICT integration and student performance are unlikely to be due to chance. Overall, the results highlight the positive impact of ICT tools on enhancing students' engagement, understanding, and achievement in Mathematics in upper secondary schools within the Muhanga District.

## 5. Conclusion and Discussion

### 5.1 Conclusion

The study demonstrates that ICT tools play a crucial role in enhancing students' learning experiences and academic performance in Mathematics. Analysis of the impact of ICT tools on student achievement reveals consistently strong positive relationships across all variables examined, with correlation coefficients ranging from 0.605 to 0.864. All p-values were 0.000, well below the 0.05 significance threshold, indicating that these relationships are statistically significant. The chi-square results further confirm that the use of ICT tools is closely associated with students' performance, highlighting a meaningful connection between the variables.

Consequently, the null hypothesis ( $H_0$ ), which suggested no significant relationship between ICT tool usage and students' academic performance in Mathematics, is rejected. The findings support the alternative hypothesis ( $H_1$ ), confirming that ICT tools have a significant and positive impact on students' understanding and achievement in Mathematics. It can therefore be concluded that integrating ICT into Mathematics instruction contributes to improved learning outcomes for upper secondary school students in the

Muhanga District, enhancing both engagement and academic success.

## 5.2 Recommendations

Based on the study's findings, the following recommendations are proposed to further improve students' performance in Mathematics:

1. The Ministry of Education in Rwanda (MINEDUC) should ensure that all schools, particularly those without access to ICT tools, are equipped with computers and other relevant resources.
2. ICT tools and resources should be made widely available to facilitate more engaging, interactive, and relevant teaching practices.
3. MINEDUC, the Rwanda Education Board (REB), and the National Examination and School Assessment Authority (NESA) should continue providing professional development programs to equip teachers with essential ICT knowledge and skills.
4. Experienced Mathematics teachers should be encouraged not only to adopt ICT tools in their teaching but also to participate in training programs to enhance their capacity for effectively integrating ICT into the teaching and learning process.

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