

# TECHNOLOGY INCLUSION IN TEACHING AND LEARNING MATHEMATICS AND STUDENTS LEARNING COMPETENCES IN PUBLIC SECONDARY SCHOOLS OF RWANDA: A CASE OF NYANZA DISTRICT

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**Abstract:** This study assessed the effects of technology inclusion in teaching and learning mathematics on students' competencies in public secondary schools in Rwanda. The specific objectives were to determine the level of technology use in teaching and learning mathematics in secondary schools in Nyanza district, Rwanda, to evaluate the competences developed by students in mathematics due to the use of technology in secondary schools in Nyanza district, and to investigate the effect of technology inclusion in teaching and learning mathematics on students' mathematics competences in secondary schools in Nyanza district, Rwanda. In order to have a comprehensive view of the subject, the study evaluated related literature by other academics on technology inclusion in teaching and learning mathematics and students learning competences. This study is useful to all stakeholders in the education sector, such as public institutions, decision-makers, district authorities, head teachers, teachers, learners, and scholars. The researcher applied a descriptive correlational study, targeting 150 students, 130 teachers, and 100 head teachers. This study selected respondents and key informants both purposefully and randomly. A study sample of 195 respondents was obtained by using Yamane's formula. Information was analyzed using the statistical package for social sciences version 21.0 to generate descriptive statistics in terms of frequency, percentage, mean, and standard deviation. Inferential statistics were produced in terms of correlation and regression coefficients for determining the size of the effect between variables. The result for the first objective on technological use in teaching and learning math indicated that 83.6% strongly agreed that they utilize computers to teach mathematics; 91.0% strongly agreed that they create mathematics-related software; 85.1% strongly agreed that teachers use computer software for data analysis and statistics; and 79.1% strongly agreed that teachers utilize math operations in electronic tools. The second objective's result on students' competences in mathematics indicated that 68.7% of teachers strongly agreed that improved grades and scores are the result of competencies developed by students in mathematics. Results from the third objective on the correlation between technology inclusion in teaching and learning mathematics and students learning competences in mathematics indicated that most measures were positively associated with each other. Since the degree of significance was less than 0.05. The teacher must also make an attempt to link what students are learning to real-world situations. This will help them realize why they need to learn what teachers are teaching by using technology. There is a need to carry out research on factors improving the effective use of ICT in mathematics teaching and learning in Rwandan secondary schools.

**Keywords:** Academic performance, Competencies, Mathematics, Technology.

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## 1. INTRODUCTION TO THE STUDY

### Problem Statement

Society today places a lot of importance on students' academic performance. The outcome of national examinations in mathematics is used as criteria for admission to science combinations of advanced level in Rwanda. Castro (2018) stated that technology inclusion is essential to improving students' performance, and strategy execution is crucial for quality and

improving students' academic results. It has been confirmed both at international, regional, and local levels that technology inclusion to improve educational outcomes is the main goal of any technology inclusion in education intervention (Kamana, 2019).

The Rwanda Ministry of Education Strategic Plan (2015–2018) emphasizes technology inclusion in education, which is expected to improve quality, teacher skills, and communication between all stakeholders, including parents, teachers, and students (Mindeduc, 2018). Available research findings attribute the students' poor achievement to a number of factors, including the students' attitude towards mathematics, the teacher's attitude towards student ability in the subject, the availability and use of resources, a poor learning environment, and a poor method of instruction. The inclusion of technology is expected to improve students' academic performance. However, Rukundo (2021) stated that teachers in Rwanda improve technology inclusion in teaching, but students' academic performance in the Rwanda Education Board (REB) has not shown significant improvement.

### Objectives of the Study

- i. To determine the level of technology use in teaching and learning mathematics in Secondary schools in Nyanza district, Rwanda.
- ii. To evaluate the competences developed by students in mathematics due to the use of technology in secondary schools of Nyanza Districts
- iii. To investigate the effect of technology inclusion in teaching and learning Mathematics on student's mathematics competences in secondary schools of Nyanza district Rwanda.

### Research Questions

- i. What is the level of technology used in teaching and learning mathematics in Nyanza district, Rwanda?
- ii. What are the competences developed by students in mathematics due to the use of technology in secondary schools in Nyanza Districts?
- iii. What is the effect of technology inclusion in teaching and learning mathematics on student competences in secondary schools of Nyanza district, Rwanda?

## 2. REVIEW OF RELATED LITERATURE

### Theoretical Literature

Literature reviews, regardless of whether they are part of a larger research study, an integrative literature review (Torraco, 2016), or a stand-alone theoretical literature review as presented in the current article, should present "the most important feature of the explanation of a model, conceptual framework, or theory" (Torraco, 2016). This following sub-section aims to present the definition of key concepts.

### Utilizing computers to teach math Learning Competence

According to Charaldi (2020), teachers can utilize technology to help students understand how topics learned in math or STEM classes can be used in real life. Instead of providing her kids with a problem-solving worksheet, educator Jennie Magiera filmed a short video in the supermarket's dairy department, posing the real-world dilemma of determining the greatest value. She tasked her pupils with determining the brand and amount of cheese to purchase based on the prices and promotions shown on the shelves. Using a smartphone, you may quickly record videos of instances like this outside of the classroom and then publish them on YouTube or the class website.

### Mathematics-related software

Mathematical software is software that is used to model, analyze, or compute numerical, symbolic, or geometric data, as well as a set of computer programs capable of solving equations or performing mathematical computations. Mathematical modeling is the creation of mathematical equations that explain a process. Once these equations are constructed, they must be solved, and the results must be examined to discover what information they provide about the process. Many discoveries have been made through researching how to solve equations that model processes and the answers that result. (Hill, 2015)

### Empirical Review

This research on the one hand, tried to look at what others had identified and added some statements about the results of their researches. The researcher, on the other hand, referred to the documents research for instance; books, internet resources and others, in order to know really what was related to the study being investigated.

### The level of technology use in teaching and learning mathematics in public secondary schools

A study conducted in Nepal by Chitrakar (2021) on the ICT competence of mathematics teachers at secondary schools in Nepal showed that their ICT competence level was proficient in the essential concepts of computers and Internet usage.

### The competencies developed by students in mathematics due to the use of technology in secondary schools

In the United States of America, Murphy (2017) conducted research on the impact of incorporating technology into a high school mathematics classroom. Mathematics has a hierarchical structure in learning, and it is critical that pupils comprehend mathematics early in their schooling.

### Effect of technology inclusion on students maths competencies

In the study conducted in South Kalimantan, Indonesia, by Muhajir & Retnawati (2020), it was indicated that the barriers faced by mathematics teachers in the digital age when implementing technology in mathematics teaching and learning included: math learning materials that were less suited to the use of technology.

### Theoretical Framework

A competence I therefore described as ‘a complex combination of knowledge, skills, understanding, values, attitudes and desire which lead to effective, embodied human action in the world, in a particular domain’ (Deakin Crick, 2008).

### Cognitive Learning Theory

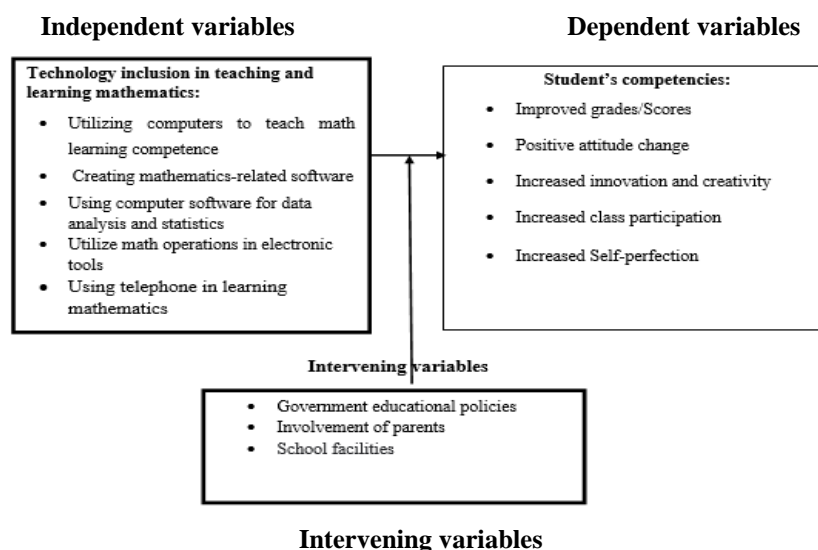
The Theory of Cognitive Development by Jean Piaget, the Swiss psychologist, suggests that children's intelligence undergoes changes as they grow. Cognitive development in children is not only related to acquiring knowledge, children need to build or develop a mental model of their surrounding world (Miller, 2011) Cognitive Learning Theory uses metacognition (thinking about thinking) to understand how thought processes influence learning.

### The Anchored Instruction Theory

The Cognition and Technology Group at Vanderbilt University presented the Anchored Instruction Educational Model in 1990. John Bransford, who is credited as the "founder" of Anchored Instruction, oversaw the study. The Anchored Instruction Theory emphasizes technology-based learning. Students take the technology as the carrier, use the reality of living world as main contents to discover problems, generate questions, and ultimately solve the problems. Guided by the Anchored Instruction Theory, a famous example of the instruction is the “Jasper Woodbury Video Series.”

### Conceptual Framework

A good scientific research should be crowned by a conceptual framework justified through logically related variables. The conceptual framework of this study relates the independent variable and to the dependent variable as well as intervening variable in the figure 2.1.



Source: Researcher, 2023

Figure 2.1: Conceptuel Framework

### 3. RESEARCH METHODOLOGY

#### 3.1 Research design.

A descriptive survey research strategy was used for this study, which also used both quantitative and qualitative methods. On the one hand, the quantitative approach was employed in a survey, in which questionnaires were mailed to teachers and a sample of students during the period of the study.

#### 3.2. Target population

A research population is often a sizable group of people or things that serve as the principal subject of a scientific inquiry. Research is carried out to benefit the general populace. However, because population numbers are so huge, it is sometimes impractical and expensive for researchers to examine every member of the community (Adam, 2020). This study's population included 130 teachers, 100 administrators, and 150 students. As a result of this, there were 380 respondents from secondary schools in Nyanza District.

#### 3.3. Sample design

A sample design is a description of procedures and strategies for gathering the required information. The information that must be gathered from which sources and through what methods is specified by the project's overall operational structure. (Solanki, 2022)

#### Sample size determination

**Table 3.1: Sample Distribution**

Category of Population	Target Population	Sample Population
Head of Teachers	100	51
Teachers	130	66
Students	150	78
<b>Total</b>	<b>380</b>	<b>195</b>

**Source: Researcher 2023**

Table 3.1 The overall population of respondents is 380, and it will be made up of 100 head teachers with a sample of 51 respondents, 130 teachers with a sample of 66 teachers, and 150 students with a sample of 78 respondents. The overall sample size will be 195 people.

### 4. RESEARCH FINDINGS, INTERPRETATIONS AND DISCUSSIONS

#### 4.1 Presentation of Findings

The study analyzes data gathered in accordance with research objectives and dependent variables. The study gathered qualitative and quantitative information from 195 respondents and determined the level of technology use in teaching and learning mathematics in secondary schools in Nyanza district, Rwanda. evaluated the competences developed by students in mathematics due to the use of technology in secondary schools in Nyanza Districts and investigated the effect of technology inclusion in teaching and learning mathematics on students' mathematics competences in secondary schools in Nyanza District, Rwanda.

#### 4.2 The level of technology use in teaching and learning mathematics in Secondary schools in Nyanza district

The research identified the technology use in teaching and learning mathematics in Secondary schools in Nyanza district. Most technology used in teaching and learning included: use computers to teach math learning competence, creating mathematics-related software, using computer software for data analysis and statistics, utilize math operations in electronic tools and Using telephone in learning mathematics

**Table 4.1: Teacher's Perception on the level of technology use in teaching and learning mathematics in Secondary schools in Nyanza district**

Factors	Strongly Disagree		Disagree		Not Sure		Agree		Strongly Agree		Total	Mean	Sdv
	N	%	N	%	N	%	N	%	N	%			
Teacher utilize computers to teach mathematics using technology in teaching and learning mathematics.	3	4.5	1	1.5	0	0.0	7	10.4	56	83.6	66	1.32	.929
Teacher create mathematics-related software to use technology in teaching and learning mathematics.	0	0.0	2	3.0	2	3.0	2	3.0	61	91.0	66	1.238	.854
Teacher use computer software for data analysis and statistics to present the technology in teaching and learning mathematics.	2	3.0	2	0.0	1	1.5	5	7.5	57	85.1	66	1.313	.891
Teacher utilize math operations in electronic tools to show that I use technology in teaching and learning mathematics.	1	1.5	3	4.5	4	6.0	6	9.0	53	79.1	66	1.403	.905
Teacher use the telephone in teaching and learning mathematics in secondary indicates the use of technology in teaching and learning mathematics.	0	0.0	2	3.0	2	3.0	2	3.0	60	89.6	66	1.328	1.005

**Source: Primary Data (2023)**

Results in Table 4.1 evidence responses on the perception of teachers on technology use in teaching and learning mathematics in secondary schools in Nyanza district. Accordingly, 56 (83.6%) of teachers strongly agreed that they utilize computers to teach mathematics using technology in teaching and learning mathematics; 61 (91.0%) teachers strongly agreed that they create mathematics-related software to use technology in teaching and learning mathematics; 57 (85.1%) teachers strongly agreed that teachers use computer software for data analysis and statistics to present the technology in teaching and learning mathematics; and 53 (79.1%) teachers strongly agreed that teachers utilize math operations in electronic tools to show that they use technology in teaching and learning mathematics.

**Table 4.2: Student's Perception on the level of technology use in teaching and learning mathematics in Secondary schools in Nyanza district**

Factors	Strongly Disagree		Disagree		Not Sure		Agree		Strongly Agree		Total	Mean	Sdv
	N	%	N	%	N	%	N	%	N	%			
Utilizing computers in learning helped me think logically and increased my scores.	5	6.4	3	3.8	5	6.4	12	15.4	53	69.9	78	1.653	1.171
Mathematics-related software is increasing innovation and creativity.	3	3.8	4	5.1	4	5.1	5	6.4	62	79.5	78	1.474	1.065
Using computer software for data analysis and statistics, helped by my teacher, helped me increase my self-perfection.	4	5.1	4	5.1	5	6.4	7	9.0	58	74.4	78	1.577	1.145
Utilizing math operations in electronic tools helped me solve problems in different ways.	3	3.8	6	7.7	6	7.7	10	12.8	53	67.9	78	1.66	1.147
Using the telephone in learning mathematics indicates the technology involved in using mathematics.	4	5.1	5	6.4	6	7.7	7	9.0	56	71.8	78	1.641	1.184

**Source: Primary Data (2023)**

In Table 4.2, 69.9% of students strongly agreed that utilizing computers in learning helped me think logically and increased my scores. 79.5% of students strongly agreed that mathematics-related software is increasing innovation and creativity. 74.4% of students strongly agreed that using computer software for data analysis and statistics, helped by my

teacher, helped me increase my self-perfection. 67.9% of students strongly agreed that utilizing math operations in electronic tools helped me solve problems in different ways, and 71.8% strongly agreed that using the telephone in learning mathematics indicates the technology involved in using mathematics.

#### 4.2.1 The competences developed by students in mathematics.

This study evaluate the competences developed by students in mathematics due to the use of technology in secondary schools of Nyanza Districts through Improved grades/Scores, Positive attitude change, Increased innovation and creativity, Increased class participation and Increased Self-perfection

**Table 4.3: The perception of teachers on the competences developed by students in mathematics due to the use of technology in secondary schools of Nyanza Districts**

Factors	Strongly Disagree		Disagree		Not Sure		Agree		Strongly Agree		Total	Mean	Sdv
	N	%	N	%	N	%	N	%	N	%			
Improved grades/Scores are the competences developed by students in mathematics	4	6.0	2	3.0	4	6.0	11	16.4	46	68.7	66	1.611	1.127
Positive attitude change the competences developed by students in mathematics	2	3.0	3	4.5	2	3.0	2	3.0	55	82.1	66	1.388	.968
Increased innovation and creativity the3 competences developed by students in mathematics	3	4.5	3	4.5	4	6.0	5	7.5	52	77.6	66	1.507	1.092
Increased class participation the competences2 developed by students in mathematics	2	3.0	5	7.5	5	7.5	6	9.0	49	73.1	66	1.58	1.537
Increased Self-perfection the competences3 developed by students in mathematics	3	4.5	4	6.0	4	6.0	4	6.0	52	77.6	66	1.537	1.132

Source: Primary Data (2023)

According to table 4.3, 68.7% of teachers strongly agreed that improved grades and scores are the result of competencies developed by students in mathematics. 82.1% teachers strongly agreed that a positive attitude changes the competencies developed by students in mathematics. Furthermore, 77.6% of teachers strongly agreed that increased innovation and creativity were the competences developed by students in mathematics; 73.1% strongly agreed that increased class participation was the competence developed by students in mathematics; and 76.6% strongly agreed that increased self-perfection was the competence developed by students in mathematics.

**Table 4.4: Teachers' perception on the factors that affect classroom activities and academic performance**

Statement	Strongly Disagree		Disagree		Not Sure		Agree		Strongly Agree		Total	Mean	Sdv
	N	%	N	%	N	%	N	%	N	%			
Improved grades/Scores are the competences developed by students in mathematics	5	6.4	3	3.8	5	6.4	13	16.7	52	66.7	78	1.44	1.02
Positive attitude change the competences developed by students in mathematics	3	3.8	5	5.1	3	3.8	5	6.4	63	80.8	78	1.666	1.169
Increased innovation and creativity the4 competences developed by students in mathematics	4	5.1	4	5.1	3	3.8	7	9.0	60	76.8	78	1.52	1.12
Increased class participation the competences3 developed by students in mathematics	3	3.8	6	7.7	6	7.7	12	15.6	51	65.4	78	1.69	1.14
Increased Self-perfection the competences4 developed by students in mathematics	4	5.1	5	6.4	6	7.7	10	12.8	53	67.9	78	1.6	1.17

Source: Primary Data (2023)

Results presented in table 4.4 show that 66.7% students strongly agreed that improved grades and scores are the competences developed by students in mathematics, 80.8% strongly agreed that positive attitude change is the competence developed by students in mathematics, and 76.8% strongly agreed that increased innovation and creativity are the competences developed by students in mathematics. 65.4% of students strongly agreed that increased class participation was a result of the competences developed by students in mathematics, and 67.9% strongly agreed that increased self-perfection was a result of the competences developed by students in mathematics.

## 5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

### Summary of Findings

This study was carried and determine the level of technology, use in teaching and learning mathematics in Secondary schools in Nyanza district, Rwanda, evaluated the competences developed by students in mathematics due to the use of technology in secondary schools of Nyanza Districts and investigated the effect of technology inclusion in teaching and learning Mathematics on student's mathematics competences in secondary schools of Nyanza district Rwanda.

### The level of technology, use in teaching and learning mathematics in Secondary schools in Nyanza district

Objective one of the research determined the level of technology used in teaching and learning mathematics in secondary schools, such as utilizing computers to teach math learning competence, creating mathematics-related software, using computer software for data analysis and statistics, utilizing math operations in electronic tools, and using the telephone in learning mathematics.

Results indicated that 83.6% of teachers strongly agreed that they utilize computers to teach mathematics using technology in teaching and learning mathematics; 91.0% strongly agreed that they create mathematics-related software to use technology in teaching and learning mathematics; 85.1% strongly agreed that teachers use computer software for data analysis and statistics to present the technology in teaching and learning mathematics; and 79.1% strongly agreed that teachers utilize math operations in electronic tools to show that they use technology in teaching and learning mathematics. In addition, 89.6% strongly agreed that teachers use of the telephone in teaching and learning mathematics in secondary school indicates the use of technology in teaching and learning mathematics.

On the other hand, the students' perception 69.9% of students strongly agreed that utilizing computers in learning helped me think logically and increased my scores. 79.5% of students strongly agreed that mathematics-related software is increasing innovation and creativity. 74.4% of students strongly agreed that using computer software for data analysis and statistics, helped by my teacher, helped me increase my self-perfection. 67.9% of students strongly agreed that utilizing math operations in electronic tools helped me solve problems in different ways, and 71.8% strongly agreed that using the telephone in learning mathematics indicates the technology involved in using mathematics.

### The competences developed by students in mathematics due to the use of technology.

This research evaluated the competences developed by students in mathematics due to the use of technology in secondary schools in Nyanza Districts through improved grades and scores, increased innovation and creativity, increased class participation, and increased self-perfection. The competences developed by students in mathematics due to the use of technology in secondary schools in Nyanza Districts, 68.7% strongly agreed that improved grades and scores are the result of competencies developed by students in mathematics. 82.1% strongly agreed that a positive attitude changes the competencies developed by students in mathematics. Furthermore, 77.6% strongly agreed that increased innovation and creativity were the competences developed by students in mathematics; 73.1% strongly agreed that increased class participation was the competence developed by students in mathematics; and 76.6% strongly agreed that increased self-perfection was the competence developed by students in mathematics.

### The effect of technology inclusion in teaching and learning Mathematics on student's mathematics competences.

The correlation and regression results established the existence of positive correlation between technology inclusion in teaching and learning Mathematics on student's mathematics competences in secondary schools of Nyanza district Rwanda, the association were positively related because p-value was less than 0.05, the study evidenced a positive correlation between technology inclusion in teaching and learning Mathematics on student's mathematics competences in secondary schools of Nyanza district Rwanda.

## Conclusions

Reconsidering findings from this present research, it concludes: To the first research objectives, the study reveals that most commonly, school activities such as utilizing computers to teach math learning competence, creating mathematics-related software, using computer software for data analysis and statistics, utilizing math operations in electronic tools, and using the telephone in learning mathematics affect students' mathematics competences in secondary schools.

The researcher reveals that students in Nyanza Districts' secondary schools develop competences in mathematics, resulting in improved grades, positive attitudes, increased innovation, creativity, class participation, and self-perfection. Students' positive attitudes also impact these competencies, with a majority expressing satisfaction with their learning outcomes.

Results from objective three reveal that The study found a strong correlation between using computers to teach math learning competence, creating mathematics-related software, using computer software for data analysis and statistics, and using math operations in electronic tools. Additionally, there was a significant relationship between increased innovation and creativity, class participation, and using computers for teaching math learning competence, creating mathematics-related software, using computer software for data analysis and statistics, and using math operations in electronic tools. The level was positively and statistically correlated since most of their level of significance level were more 0.05 in association with student's mathematics competences in secondary school's subject public secondary school in Nyanza District, Rwanda.

## Recommendations

Reconsidering concluding remarks from the study findings and information argued that the author attempted to make some recommendations to the study.

All people involved in education sector in Nyanza District are recommended to work collaboratively in order to enhance the Student academic performance among all secondary school students in public and private primary schools in both general education and TSS schools to all lessons including mathematics subject.

MINEDUC through Rwanda Education Board is recommended to avail enough teaching and learning materials including ICT Tools which are adequate in enhancing student activities during teaching among students at their early age. MINEDUC should provide enough trainings intended to boost teachers' ability to teach by using technological tools in teaching mathematics

More training must be given to the teachers of how to train student on how to use technology in learning mathematics so that to help them to rise their level of academic performance.

The teacher must also Make an attempt to link what your students are learning to real-world situations. This will help them realize why they need to learn what you're teaching by using technology.

## Suggestions for Further Studies

The researcher assessed the effects of technology inclusion in teaching and learning mathematics on students 'competencies in public secondary schools Rwanda.

Therefore, there is a need to carry out a research on Factors Improving the Effective Use of ICT in Mathematics Teaching and Learning in Rwandan Secondary Schools.

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