



ICT Performance Indicators in Formal Education at the Secondary School Level in Rwanda

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Abstract. The objective of this study is to evaluate the performance of ICT indicators used to support education in formal secondary schools in Rwanda. By examining related research papers, Rwandan ministerial reports, and relevant journals, we were able to obtain secondary data for analysis. Additionally, primary data were collected from 46 secondary schools through a questionnaire. Overall, Rwanda has demonstrated significant improvement over the course of just one year. The ratio of students to computers increased from 27:1 in 2016 to 7:1 in 2017, and access to electricity increased from 25% in 2016 to 95.7% in 2017. Additionally, the number of ICT-trained teachers increased from 2.5% in 2016 to 43.7% in 2017. However, there are still improvements to be made; only 43.5% of schools have an Internet connection, and, of those, only 37.1% of students actually use it.

Keywords: Information and communication technology · ICT Policy · Indicators · Education · Rwanda

1 Introduction

The purpose of this project is to examine the procedures used in Rwandan schools to measure and evaluate information and communications technology (ICT) indicators in education. According to the Rwanda Ministry of Youth and ICT (MYICT), the Rwandan government is following an ambitious twenty-year plan to enhance its ICT services. “The revolution started when ICT was regarded as a necessity, not a choice,” said the Minister of MYICT, Jean Philbert Nsenigimana, when Rwanda started structuring the 2020 National Information Communication Infrastructure (NICI) plan. The plan aims to strengthen education that eradicates the current ICT gap, among other goals.

Given the growing role of ICT in education, there is an increasing need for monitoring the development of this integration and analyzing the reliability and validity of the indicators used to determine this change. This will allow policymakers to monitor the progress of the country relative to the national

targets and other adequate benchmarks. This national focus generated a need for analyzing the performance of ICT indicators in education in Rwanda, as it is the main pillar for the development of the country. Thus, the objectives of this analysis are as follows:

- Measure the accuracy of ICT indicators for the use of ICT in education in Rwanda.
- Evaluate International Telecommunication Union (ITU) performance indicators used in Rwanda to support the use of ICT in education.
- Identify and analyze any trends in the results and make recommendations.

1.1 Variables

The scope of this project is limited to educational institutions and their students [1]. Both public and private educational institutions at International Standard Classification of Education (ISCED) [2] Levels 2 and 3 are included, and the students are limited to those entitled to use school computers. This study focuses on five of the nine ICT indicators in education based upon data available for those five [3]:

- ED4: Learners-to-computer ratio in schools with computer-assisted instruction.
- ED5: Proportion of schools with Internet access, by type of access.
- ED6: Proportion of learners who have access to the Internet at school.
- ED8: Proportion of ICT-qualified teachers in schools.
- EDR1: Reference indicator: Proportion of schools with electricity.

1.2 Measurement of Performance Indicators by ITU and UNESCO

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), there are five main categories to focus on in performance measurement and analysis of ICT indicators in education.

- Policy
- Technology Infrastructure and Access
- ICT Curriculum
- Teaching and Teaching Support Staff
- Learning Process and Outcomes

These indicators can be used at the international, regional, national, sub-national, and individual school levels for monitoring and supporting policy formulation, monitoring and evaluation, and decision making. The analysis also assists in comparing ICT infrastructure, access, usage, and outcomes. Most of the quantitative data required are collected from the educational institutions during school censuses or surveys, and analysis is completed by calculation. The following section outlines five of the indicators and how they are analyzed mathematically [3].

ED4: *Learner-to-computer ratio in schools with computer-assisted instruction.*

$$\frac{\sum_{h=2}^3 LC_h^t}{\sum_{h=2}^3 CP_h^t} \quad (1)$$

Where LC_h^t is the number of learners entitled to use computer laboratories at school as pedagogical aid at level of education h in school year t . CP_h^t is the number of computers available for pedagogical use at level of education h in school year t .

In the absence of nationally defined norms by pedagogues, a ratio of one learner to one computer indicates a perfect adequacy in the provision of a computer to all learners officially entitled to benefit from it in schools that offer computer-assisted instruction (CAI) [4].

ED5: *Proportion of schools with Internet access by type of access.*

This indicator is utilized to compare the number of schools with Internet access with the total number of schools in a given academic year [4]. The following expression is used to calculate the proportion of schools with Internet access:

$$\frac{\sum_{h=2}^3 EII_{h,s}^t}{\sum_{h=2}^3 EI_h^t} * 100 \quad (2)$$

Where $EII_{h,s}^t$ is the number of educational institutions with access to the Internet at level of education h by type of Internet access in school year t and EI_h^t is the number of educational institutions at level of education h in school year t . The indicator is expressed in percentages and the high expectation is 100% [4].

ED6: *Proportion of learners who have access to the Internet at school.*

The purpose of evaluating this indicator is to measure Internet accessibility among learners for educational purposes. The expression used is:

$$\frac{\sum_{h=2}^3 LI_{h,s}^t}{\sum_{h=2}^3 L_h^t} * 100 \quad (3)$$

Where $LI_{h,s}^t$ is the number of learners entitled to use Internet at school as a pedagogical aid at education level h in school year t and L_h^t is the number of learners enrolled at education level h in school year t . The indicator is expressed in percentages and the high expectation is 100%.

ED8: *Proportion of ICT-qualified teachers in schools.*

This indicator aims to measure the extent to which secondary school teachers have the required ICT training to teach basic computer skills or computing classes [4]. The expression used is:

$$\frac{\sum_{h=2}^3 TTB_{h,s}^t}{\sum_{h=2}^3 T_h^t} * 100 \quad (4)$$

Where $TTB_{h,s}^t$ is the number of teachers trained to teach basic computer skills or computing at level of education h in school year t and T_h^t is the number of teachers at level of education h in school-year t . The indicator is expressed in percentages and the high expectation is 100% [4].

EDR1: *Reference indicator: Proportion of schools with electricity.*

This indicator measures the availability of electricity as a minimum, necessary condition for ICT to be introduced to schools, although not all ICT tools used in education require a permanent and sustainable supply of electricity. The indicator is measured as the percentage of schools with electricity compared to the total number of schools, with a high expectation of 100% [4].

$$\frac{\sum_{h=2}^3 EIE_{h,s}^t}{\sum_{h=2}^3 EI_h^t} * 100 \quad (5)$$

Where $EIE_{h,s}^t$ is the number of educational institutions with electricity at level of education h in school-year t and EI_h^t is the number of educational institutions at level of education h in school-year t .

2 Design and Methodology

The following steps were taken to provide appropriate context for the work and collect and analyze data.

1. Review literature: Relevant research papers, governments, ITU and UNESCO reports, newspapers, and journals.
2. Identify indicators: Collected from annual, country-level school censuses.
3. Collect secondary data: Collected from websites of the Ministry of Education (MINEDUC) and Ministry of Youth and ICT (MYICT), newspapers, and journals. MINEDUC provided important information about policies focused on using ICT in education and updated reports and statistics, while MYICT provided crucial information about ICT integration in education.
4. Collect primary data: Of the 2108 schools who received the questionnaire, only 31 secondary school administrators participated. Administrators, specifically, were targeted as they have a better understanding of ICT tools than most students. The survey was based on one used by ITU and comprises of both open and closed questions. The survey was also anonymous to encourage honesty and depth of answers.

3 Results

The following section details the results from the secondary data concerning the ICT performance indicators collected.

3.1 The Role of ICT in Education

The Rwandan government outlined the specific aims of ICT use in the education sector as follows [1]:

- Improve administrative efficiency.
- Disseminate teaching and learning materials to teachers and students.
- Improve the ICT skills of teachers and students.
- Allow teachers and students access to sources of information from around the world.
- Allow educators to share ideas on education and learning.
- Encourage teachers to collaborate on joint projects and conduct lessons from a remote location.

3.2 Access to Electricity, Telephone, and Internet

Selected ICT indicators in education in Rwanda between 2006 and 2010 are represented in Fig. 1. As shown, between 2006 and 2010 Rwanda had accessibility to electricity, computers, and the Internet and use of websites in secondary schools. These elements are used as indicators of ICT integration in education, and the status and change of each is analyzed.

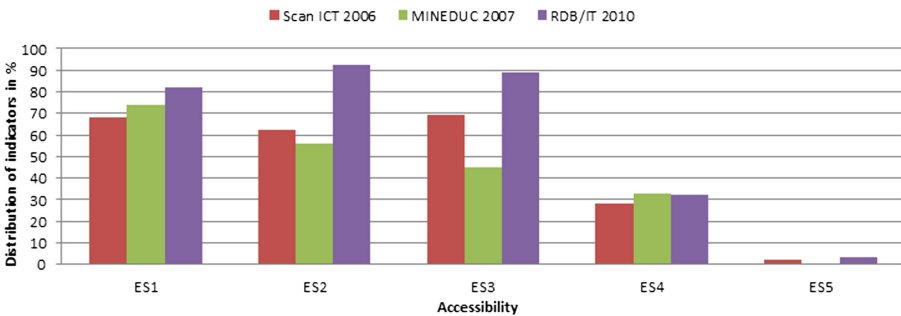


Fig. 1. Accessibility to electricity, telephone and Internet by secondary schools in Rwanda.

Figure 1 compares the percentage of schools with access to electricity (ES1), the percentage of schools with telephone access (ES2), the percentage of schools using computers (ES3), the percentage of schools with access to the Internet (ES4), and the percentage of schools with websites in 2006, 2007, and 2010 (ES5). There is a significant increase in electricity penetration in the country between 2006 and 2010, and there was adequate usage of telephones and computers. However, this does not clearly highlight if computers were accessed by school administrators or students. More sensitization on the use of websites is needed in the country where less than 5% of schools had websites in 2010.

3.3 Relevant Policies

One Laptop per Child. The One Laptop per Child program and other ministry initiatives have registered significant successes to date, with more than 200,000 laptops distributed in over 400 schools in 2015. However, with over 3 million students in Rwanda's education system, only a small proportion of students received the benefits of the use of technology in education. As a solution, the government decided to partner with POSITIVO-BGH to assemble electronic devices in Rwanda, including desktops, laptops, and tablets. This partnership strives to make such devices readily available on the market at low prices to serve both students and teachers.

One Laptop per Teacher. After the introduction of One Laptop per Child, it became clear that most teachers who are expected to instruct the students on ICT did not have computers themselves, or the capacity to use them. As a solution, the government devised a plan to train all teachers in ICT and allocate one laptop per teacher.

GiraICT. In addition to laptops, the GiraICT organization also gives teachers Internet access for six months to enhance their laptop usage and skills. The program is not only focused on supplying laptops, but it also ensures that the beneficiaries use them to improve the quality of teaching.

Investment Implication. The implementation of ICT integration in education is planned to be achieved through four phases from 2015 through 2019, with specific investment levels for each phase as shown in Fig. 2.

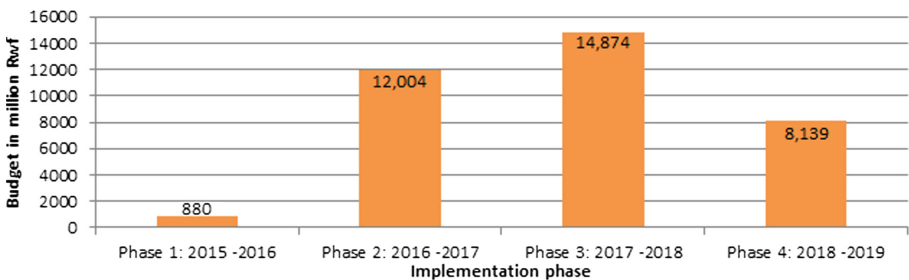


Fig. 2. Budget for ICT integration in education in Rwanda.

Challenges of ICT Integration in Education

- Poor infrastructure: Only 47% electricity coverage in public schools.
- Only 6% of primary and 18% of secondary schools connected to the Internet.
- Limited ICT resources for education.
- Turnover in expertise at learning institutions.

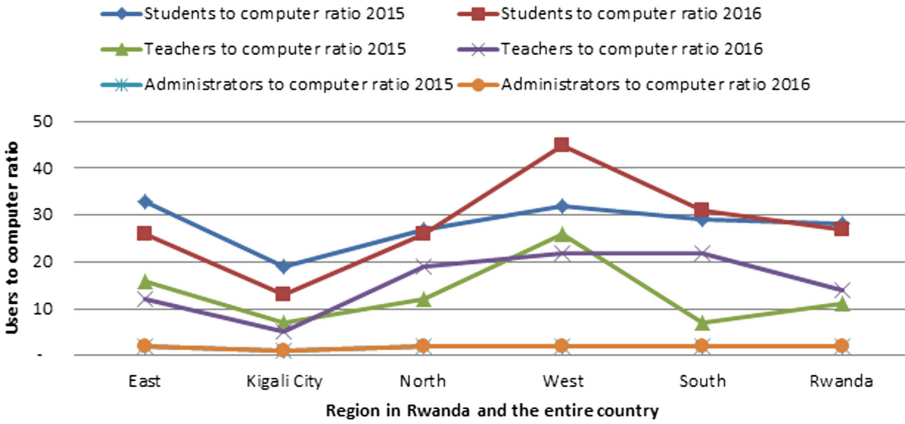


Fig. 3. Secondary school users to computer ratio in 2015 and 2016 in Rwanda.

The ratio of learners to computers and teachers to computers is high compared to the ratio of administrators to computers as shown in Fig. 3.

The ratio of learners to computers increased in the Eastern Province from 35:1 to 25:1. The ratio also increased in Kigali from 18:1 to 15:1. There was no change in the Northern Province, whereas in the Western and Southern Provinces, the ratios decrease. The reports do not comment on the cause of this decrease. There was a small change in computer accessibility in 2016 as compared to the 2015 ratios. The ratio of the total number of teachers to the number of teachers with access to computers in the country changed from 11:1 to 14:1 and the learner to computer ratio changed from 28:1 to 27:1. The change in the ratio of teachers with access to computers might have been caused by the recruitment of new teachers, while the change in learner to computer ratios might have been impacted by the One Laptop per Child program.

According to the Rwanda’s national goals, the 2016/2017 target of electrifying 65% of the country has not been achieved. As shown in Fig. 4, only 46% of secondary schools have access to electricity through the national grid [5].

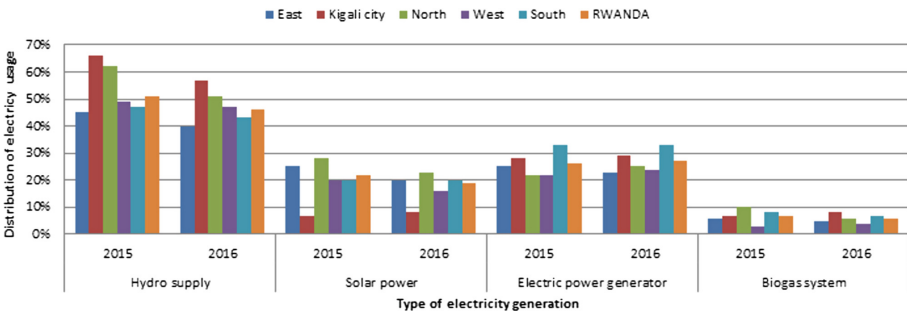


Fig. 4. Secondary schools with electricity in Rwanda in 2016.

Primary Data. The analysis of data in this section is done mathematically and discussion is given per indicator. The data collected are summarized in Table 1.

Table 1. Primary data collected

Total number of learners	22791
Number of computers	5719
Number of computers accessed by students	3730
Number of computers connected to Internet	3428
Number of learners owning computers	1357
Girls enrolled in ICT related fields	811
Learners entitled to use computers at school	22791
Learners entitled to use Internet at school	22791
Number of learners who have access to Internet	8450
Total number of teachers	817
Teachers trained to teach basic computer skills	357
Teachers who use ICT facilities	366
Teachers who teach basic computer skills	124
Number of teachers trained to teach using ICT facilities	464
Total number of schools	46
Schools with Internet	20
Schools with electricity	44

ED4: *Learners-to-computer ratio in schools with computer-assisted instruction.*

$$\frac{\sum_{h=2}^3 LC_h^t}{\sum_{h=2}^3 CP_h^t} = \frac{22791}{3730} = 7 \quad (6)$$

In secondary schools in Rwanda, one computer is shared by seven students. Although there is improvement compared to the year 2016, when 27 students were sharing one computer, the number leaves room for further improvement. The government of Rwanda has a vision of having one laptop per child.

ED5: *Proportion of schools with Internet access by type of access.*

$$\frac{\sum_{h=2}^3 EII_{h,s}^t}{\sum_{h=2}^3 EI_h^t} * 100 = \frac{20}{46} * 100 = 43.5\% \quad (7)$$

ED6: *Proportion of learners who have access to the Internet at school.*

$$\frac{\sum_{h=2}^3 LI_{h,s}^t}{\sum_{h=2}^3 L_h^t} * 100 = \frac{8450}{22791} = 37.1\% \quad (8)$$

Although about 44% of secondary schools have access to the Internet, it is seen that only 37.1% of students use Internet as a pedagogical aid.

ED8: *Proportion of ICT-qualified teachers in schools.*

$$\frac{\sum_{h=2}^3 TTB_{h,s}^t}{\sum_{h=2}^3 T_h^t} * 100 = \frac{357}{817} = 43.7\% \tag{9}$$

According to Fig 5, only 43.7% of all teachers are trained in ICT, including educators who teach computer science. This indicates a large gap in the education potential of ICT facilities.

EDR1: *Reference indicator: Proportion of schools with electricity.*

$$\frac{\sum_{h=2}^3 EIE_{h,s}^t}{\sum_{h=2}^3 EI_h^t} * 100 = \frac{44}{46} * 100 = 95.7\% \tag{10}$$

Of the secondary schools in Rwanda, 95.7% are electrified. This is a small step toward implementing ICT curricula and facilities, since all ICT tools function using electricity. The above performance indicators of 2017 are summarized in Fig. 5.

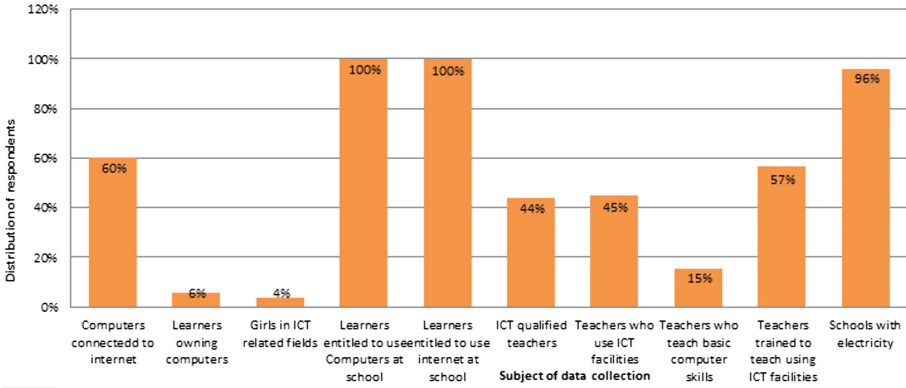


Fig. 5. Summary of all questions represented on a histogram.

4 Recommendations

Based on the successes of Rwanda’s advancement of ICT, all East African countries should define and specify ICT integration in education and use ITU performance indicators to evaluate their achievements. The significance of ICT warrants its own sector, budget, and policy. Rwanda should focus on Internet access

and its usage in all schools in rural areas as well as in cities so that all schools can progress at the same pace and provide better quality education. The government of Rwanda should also focus on infrastructure and capacity building as well as developing teacher awareness of the importance of the role of ICT in educational development. In addition to this, the government should assist private schools in obtaining ICT equipment. The government should focus on expanding off-grid solutions to assist schools in rural areas to obtain electricity so that they can make essential technological advancements.

5 Conclusion

By implementing clear ICT policies for integration in the education sector, Rwanda has made significant strides toward technological advancement compared to its neighboring countries, even though it still has a number of areas in which to improve. All indicators measured in this paper show improvement compared to the results of previous years as.

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