Supporting Coding among Rwandan Adolescents & Teachers through the Curriculum & Clubs Heading (SCRATC2H) for Rwanda 2050

Needs Assessment Report

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List of Abbreviation

CBC	Competence Based Curriculum
CPD	Continuous Professional Development
DDE	District Director of Education
DEO	District Education Officer
ESSP	Education Sector Strategic Plan
FGD	Focus Group Discussion
HT	Head Teacher
ICT	Information and Communication Technology
LTLT	Leading, Teaching and Learning Together
RCA	Rwanda Coding Academy
REB	Rwanda Basic Education Board
SEI	Sector Education Inspector
STEM	Science, Technology, Engineering and Mathematics
TVET	Technical and Vocational Education and Training

Summary

This report presents the findings of a Needs assessment study that was carried out to ensure the contextualization and identification of key priorities and strategies for the implementation of the project "Supporting Coding among Rwandan Adolescents & Teachers through the Curriculum & Clubs Heading for Rwanda 2050 (Scratc^{2}h 2050)"aiming at equipping 135 ICT and STEM teachers of 45 secondary schools in Kayonza district with the competences needed to initiate and facilitate after school Scratc^{2}h 2050 coding clubs for secondary school learners and to integrate Scratch into ICT and STEM lesson plans.

The study was conducted in November 2020 in two sectors in Kayonza (Rukara and Rwinkwavu), the objectives of the study included:

1) To assess the digital literacy skills of STEM, and ICT teachers and specifically on coding.
2) To explore experiences and attitudes of students, STEM, and ICT teachers regarding coding.
3) To assess which conditions need to be in place at school, sector, and district level to ensure that SCRATCH can be integrated into STEM/ICT classes and after school clubs.
4) To understand the specific needs of girls and vulnerable groups to ensure that they can also participate in SCRATCH lessons and after-school coding clubs.

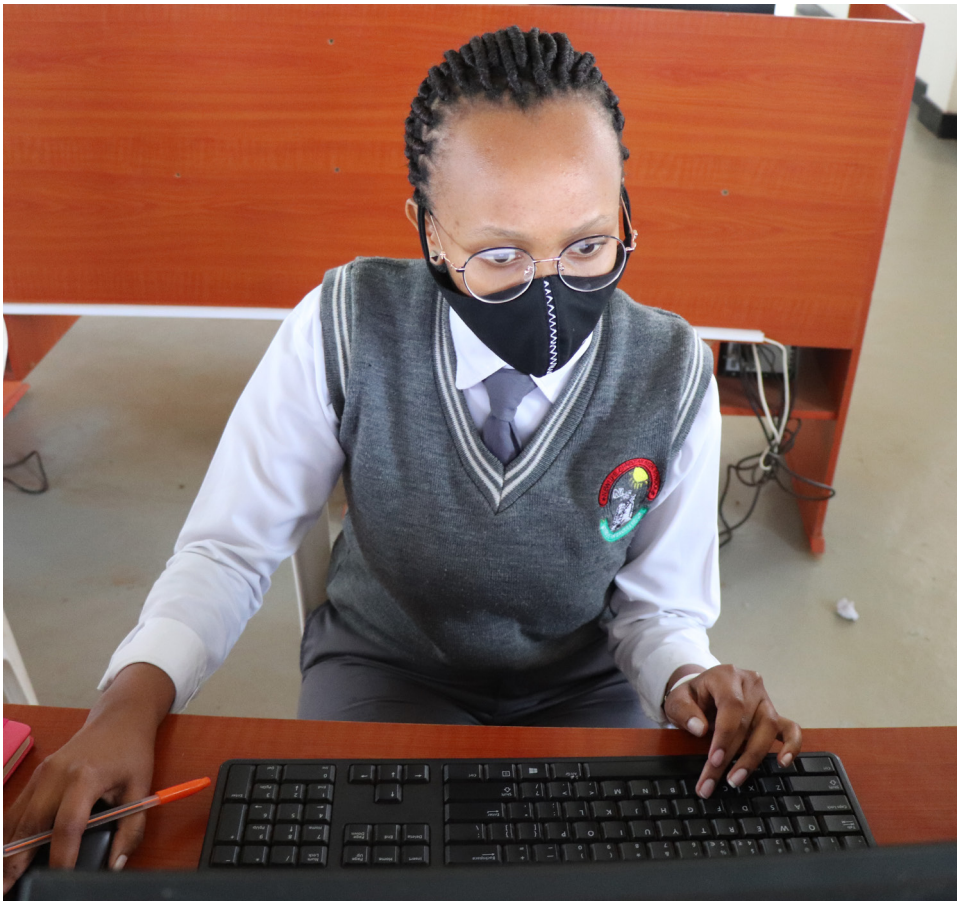
To investigate the aforementioned objectives a mixed method approach was applied using Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) complemented with Scratch exploration and digital literacy self-assessment with teachers. Overall, 10 school leaders, 19 STEM and ICT teachers and 16 students participated from 10 schools in the three sectors that took part in FGDs. Then, 2 Sector Education Inspectors (SEIs) and the District Education Officer (DEO) took part in KIIs. Lastly, the 17 teachers took part in the scratch exploration assessment and digital literacy self-assessment. For the digital literacy self-assessment 13 STEM and ICT teachers that participated in the pilot test of the Scratch pedagogical guide were included in our sample, resulting in 30 respondents for the digital literacy self-assessment.

Findings show that the environment in Kayonza secondary schools is quite diversified. In the sense that while boarding and private schools have better access to infrastructure, such as SMART classrooms; other schools still have no access to grid electricity. Besides, schools in Kayonza have low access to ICT infrastructure and ICT teachers have few opportunities for continuous professional development. And STEM subjects are still perceived as difficult by students, mostly girls. However, the government and local level officers are working with school leaders to raise awareness on the benefits of studying ICT and STEM subjects. The CPD learning trajectory for ICT and STEM teachers and the establishment of after school Scratch coding clubs would then address some of these challenges.

Findings reveal that in schools where ICT infrastructure is available the use of ICT tools in teaching is mostly driven by the affinity and expertise of teachers and it was highlighted that mainly STEM teachers use these tools during lessons; compared to other subject's teachers. In addition, resulting from the school closure, there is a high demand from teachers for training in using ICT tools for teaching remotely and in classrooms. The self-assessment survey showed that ICT and STEM teachers have relatively low ICT skills when it comes to using Moodle and in programming and better skills in internet navigation and Microsoft word and that ICT teachers self-report to have more ICT skills than STEM teachers. However, the SCRATCH exploration assessment proved the ability of teachers to perform the different assigned tasks to be driven by teachers' capacity to use a computer and their attitudes towards exploring the scratch platform. This study did not identify large difference in the ability of ICT teachers compared to STEM teachers. Therefore, participating in the Scratch learning trajectory and the introduction of Scratch in STEM and ICT lessons would then address most of these challenges.

Finding show that most secondary schools in Kayonza have after-school activities planned in the timetable, with difference on when they happen and what kind of activities it is. The main challenges identified for setting up after-class Scratch clubs were the compliance to sanitary and social distancing measures which prevents schools to organize clubs and access to ICT tools for all students in the club. These challenges can be addressed by allowing schools and teachers more flexibility on the organization of clubs and setting up a maximum number of students that can participate in the clubs.

Lastly, findings show that gender stereotypes around learning STEM subject restrict the number of girls choosing to pursue STEM combinations in A-level. Likewise, the design of STEM lessons and examination restrict the number of visually impaired students to choose STEM combinations in A-level. In addition to that, it was highlighted the number of female STEM teachers is still low in secondary schools in Kayonza. Considering ICT, while boys tend to be more curious about using ICT tools with a good enabling system/ environment it has shown possible to insure access to ICT for visual impaired students. These challenges are expected to be address by ensuring that female teachers and a specialist in teaching ICT to visual impaired students are included in the learning trajectory and that a gender balance and including visual impaired students is required when selecting club members. In addition, more awareness need to be done regularly about these inclusion gaps and stereotypes to relevant stakeholders.



Introduction

In its Vision 2050, Rwanda aims to move from an economy heavily dependent on agriculture to a service driven economy. To achieve this, the ICT sector will play a central role; moreover, ICT can act as a means of self-employment. However, currently the digital sector faces some challenges: digital literacy remains low in Rwanda and many adolescents lack the problem-solving, self-regulatory and creative skills crucial for boosting innovation. Moreover, there is still a gender gap in learning outcomes for STEM in secondary education and relatively few girls choose to pursue higher education in STEM fields.

In education, the use of ICT is considered an important strategy for achieving the transformation envisioned in Vision 2050. This is also in line with the country's strategic instrument: The Education Sector Strategic Plan (ESSP) which stipulates that encouraging innovations in the education sector is a central element in improving education[1]. In addition, introducing innovative solutions to address existing challenges in the sector will act as a catalyst for achieving overall sector goals. To achieve this, different activities have been put in place, such as: 1) the One Laptop Per Child (OLPC)[2] program with the distribution of laptops all over the country; the implementation of SMART classrooms in 55 % of secondary schools across the country; 2) the Tech Enabled STEM Teaching (TEST) program which comprises teaching and learning using Virtual Realities, Gamification, and Robotics programming just to mention few of them and 3) the Scratch program; OLPC laptops came installed with Scratch.

Scratch is a free and open-source coding tool, which can be used offline. Using Scratch, youngsters learn to create stories, games and animations based on code. It is the perfect tool to introduce creative and project-based learning, as well as teach coding concepts and computational thinking. Instead of using commands (difficult for beginners), Scratch works by building simple algorithms through a building block format. It can also be used for a range of educational and entertainment constructionist purposes from math and science projects, including simulations and visualizations of experiments, recording lectures with animated presentations, to social sciences animated stories, and interactive art and music.

In 2013, Rwanda Basic Education Board (REB) introduced Scratch in Rwandan primary schools, hosting annual Scratch competitions (Scratch Days) for primary schools to promote digital literacy and programming and prepare future engineers. Anecdotal evidence is promising; children participating in the Scratch Days are very enthusiastic and have developed high quality animations, games, and stories. However, many teachers lack the required competences and skills to teach coding and facilitate coding clubs using Scratch. Nor do they have digital learning materials or technical and pedagogical support available. Hence, most teachers are reluctant to effectively integrate Scratch in their lessons. More recently, in 2016 Rwanda drafted an ambitious ICT in Education policy[3]. In line with these policies, REB introduced coding in the upper primary Science Elementary Technology (SET)-curriculum and lower secondary ICT curriculum and encouraged schools to form coding clubs to promote coding skills and now seeks to expand it further at secondary school level.

In the framework of Scratc^{2}h 2050, learners' digital journey will start in the classroom as STEM and ICT teachers demonstrate and integrate Scratch in STEM and ICT courses, triggering their interest. The coding clubs, next, provide the opportunity to truly develop digital skills in an enjoyable environment, combining fun with learning the programming language. Once they know the basics of Scratch, the learning curve steepens, and learners will eventually be able to digitally recreate a board game they played or create stories using their own storyline and characters. Gaining digital fluency, they will become part of a vibrant online community, where they can exchange ideas and materials, chat and continue to design and create their own projects.

[1] MINEDUC. (2018). Education Sector Strategic Plan 2018/19 - 2023/24.

[2] OLPC Wiki (2011). OLPC Rwanda. [ONLINE] Available at: http://wiki.laptop.org/go/Rwanda

[3] MINEDUC. (2016). ICT in Education Policy.

It was against this background that VVOB in partnership with Rwanda Education Board (REB) and the Rwanda Coding Academy (RCA) is piloting a project of 2 years in Kayonza district with the financial support of the Belgian Government. The aim of this pilot project is to equip 135 ICT and STEM teachers of 45 secondary schools in Kayonza district with the competences needed to initiate and facilitate after school Scratch 2050 coding clubs for secondary school learners and to integrate Scratch into ICT and STEM lesson plans. To this end, VVOB will train secondary school STEM and ICT teachers on coding and its benefits through blended learning. After training, they will continue to develop professionally through participation in ongoing online and face-to-face ScratchEd Meetups.

The project is built around four pillars:

1. Development of a Scratc^{2}h 2050 pedagogical guide, complemented by ICT and STEM lesson plans and Open Education Resources (OERs)

2. CPD trajectory for ICT and STEM teachers on digital literacy skills, Scratch, and coding clubs

3. Professional learning communities of ICT and STEM teachers

4. Establishment of after school Scratc^{2}h 2050 coding clubs

Overall, the objective of the project is to support the upscaling or replication of initiatives that close the digital divide for vulnerable groups (youth, women, unemployed, refugees and migrants) by improving digital literacy and skills through D4D initiatives in education, training, and the world of work. More specifically, this project will ensure that teachers acquire proficiency across digital literacy skills, the competencies to facilitate after-school Scratch clubs and the skills needed to integrate Scratch into ICT/STEM lessons plans. This needs assessment study is part of a first step in the SCRATC^{2}H 2050 project planning, monitoring, evaluation, and learning strategy and will help to ensure that the programme is sufficiently contextualized and addresses key priorities and strategies. The needs assessment involved programme stakeholders and beneficiaries to capture baseline indicators and provide evidence on how to improve and refine the programme. Therefore, the objectives of this needs assessment were as follows:

1. To assess the digital literacy skills of STEM, and ICT teachers and specifically on coding and assess whether there are any differences in skills.

2. To explore experiences and attitudes of students, STEM, and ICT teachers regarding coding.

3. To assess which conditions, need to be in place at school, sector, and district level to ensure that Scratch can be integrated into STEM/ICT classes and after school clubs.

4. To understand the specific needs of girls and vulnerable groups to ensure that they can also participate in Scratch lessons and after-school coding clubs.

The last objective is crosscutting and was integrated into the sampling strategy and the interview guides. Vulnerable groups are defined by the UNDP[4] as: "populations that live in poverty without access to safe housing, water, sanitation and nutrition and those who are stigmatized, discriminated against, marginalized by society and even criminalized in law, policy and practice". In the context of this project, vulnerable group will consider any youth, women, unemployed, refugees, migrants etc. with challenges in accessing digital skills and/or infrastructure. Thus, this study included the needs of vulnerable groups to ensure that no one is felt left behind in this project.

[4] UNDP (2017). Vulnerable and Key population. Accessible at: Vulnerable and key populations | United Nations Development Programme | capacities, focus, legal (undp-capacitydevelopment-health.org)

Methods

This needs assessment applied a mixed method approach to investigate the aforementioned objectives. Focus Group discussions and in-depth interviews were triangulated with quantitative data from a self-assessment survey for teachers.

Sampling

Kayonza district is one of the 7 districts in the eastern province. It has 12 sectors Murundi, Kabare, Gahini, Rukara, Nyamirama, Mukarange, Kabarondo, Rwinkwavu, Mwiri, Ndego, Murama and Ruramira. The main urban sector is Mukarange, but the district has other urban nodes in Kabarondo, Rukara and Gahini.[5] According to the latest Rwanda Education statistics (MINEDUC, 2019), Kayonza has 52 secondary schools; including Technical and Vocational Education and Training (TVET) and general education schools. The population considered in our study is limited to 45 general secondary schools in Kayonza districts which were selected for the Scratch project, unevenly spread across the district. Since not all 45 schools could be selected for this study, we drew a sample. To draw this sample, we started by purposively selected two sectors; Rwinkwavu and Rukara; using the following predefined criteria:

1) Representation of urban and rural sectors,

2) Balanced representation of different school financing status (i.e., government aided, public and private), to ensure that we capture the disparities that may arise from the difference in the source of financing; and

3) The gender of head teachers (HT), to ensure a balanced representation of female-led schools in the sample.

This led to the selection of 9 secondary schools, 5 schools from Rukara and 4 schools from Rwinkwavu sector. In addition to these criteria, access to a SMART classroom was included as a selection criterion to have at least one school with a SMART classroom where teachers can use computers in the classroom for the Scratch exploration assessment. In addition to the nine schools, we also purposively selected one additional school in Gahini sector that hosts children living with visual impairment. A separate interview was organized with the HT and two ICT and STEM teachers from the school to understand the specific needs of that school. Table 1 provides an overview of the characteristics of the ten schools included in this needs assessment.

Table 1: Overview of the selected schools

School status				Access to a SMART classroom		Gender HT	
Private	Government Aided	Public	Special Needs school*	Yes	No	Female	Male
1	5	4	1	6	4	2	8
Total	**10**						

*Also, a government aided and boarding school.

As we can see in Table 1, out of the 10 schools in Gahini, Rukara and Rwinkwavu sectors we ended up with 4 government aided schools, 4 Public schools,1 private school and one special needs school. Six schools have a SMART classroom, and two schools are led by a female headteacher.

[5] National Institute of Statistics of Rwanda (NISR), Ministry of Finance and Economic Planning (MINECOFIN) [Rwanda]; 2012. Rwanda Fourth Population and Housing Census. District Profile: Kayonza.

Instruments

To meet the objectives, this needs assessment relied on primary data collected at the administrative local government level and at school level in Kayonza.

At local government level interviews with the District Director of Education (DDE) and the Sector Education Inspectors (SEIs) aimed at understanding what conditions need to be in place at district and sector level to ensure that Scratch can be integrated into STEM classes and after school clubs in Kayonza. The interviews also helped to get a general understanding of the knowledge and capability of teachers and students in digital literacy and coding. The interview guides for the DDE and SEIs focused on:

- Current situation of ICT and STEM education
- Current challenges and best practices in ICT and STEM education
- Situation and need in terms of learning and teaching using ICT in secondary schools.
- Situation and need in terms of organizing extra-curricular activities/ clubs at school, sector, or district level.

At school level, focus groups discussions (FGDs) were conducted with HTs, teachers, and students. The discussions focused on:

- Current knowledge and skills of teachers and students in digital literacy and coding and the needs/ gaps.
- Current situation and needs for students and teachers to access ICT and internet infrastructure for learning and teaching.
- Clubs that are available at school, attendance rate of students in existing clubs
- Challenges with regards to organizing after-school clubs
- Challenges and recommendation on integration of coding into STEM and ICT classes and after-school clubs.

During the FGDs with students, the focus was on understanding their attitudes towards coding and participating in clubs at schools. The discussions with students also focused on exploring student's learning experience.

In addition to participating in FGDs, ICT and STEM teachers self-assessed their knowledge on digital skills and coding. The self-assessment instrument investigated the different aspects on ICT skills and knowledge of STEM and ICT teachers on ICT hardware, applications, and safety precautions, also used in the Needs Assessment for the LTLT programme in secondary education [6] with additional questions on coding. Furthermore, teachers participated in an exercise where they explored the Scratch environment and were assessed by the VVOB team on the following:

- Ability to use a computer.
- Ability to follow simple guidelines (In English)
- Ability to use internet for looking for information on the Internet.
- Ability to figure out how to add a sound in Scratch.
- Ability to change the background in Scratch.
- Ability to figure out how to get help with blocks in Scratch.

All the interview guides were developed in English and translated in Kinyarwanda. FGDs with HT, SEIs and students were conducted in Kinyarwanda while the interviews with teachers and DEOs were conducted in English with clarification being provided in Kinyarwanda whenever it was necessary. This was done because one member of the data collection team did not speak Kinyarwanda.

[6] VVOB, 2018. Needs Assessment Study Report; Leading, Teaching and Learning Together in Secondary Education. Available at: https://rwanda.vvob.org/download/needs-assessment-study-report

Data collection

Data collection was conducted by a team of 4 VVOB staff members. Prior to data collection, a preparatory session was organized to go through the interview guides and objectives and agree on working modalities of the data collection. In this session, VVOB staff members developed a common understanding of the needs assessment tools and data collection procedures to ensure participants' safety.

This study involved different stakeholders; from the district and sector level to stakeholders/school members at school level. Table 2 provides an overview of all the participants. At local administrative level, the Kayonza District Education Officer (DEO) in charge of secondary and TVET education was interviewed. Two SEIs were interviewed in their offices as well. The SEI of Rukara was not available at the time of the fieldwork and was replaced by the SEI of Mukarange. The SEI from Mukarange was included because it was important to have a general overview of schools from one urban sector.

At school level, FGDs were organized with HTs, STEM and ICT teachers and students. In both sectors the FGDs were organized in one centrally located school with access to a SMART classroom. Hence, HTs and teachers from other schools in the sector were asked to come to the venue for the FGDs and assessments. In the 9 schools, HTs were asked to select one STEM teacher and one ICT teacher, and the hosting school had to select in addition 8 students aged above 16 years. In both venues, 3 FGDs were organized, one with HTs, one with teachers and the other one with students. For FGDs with students, in Rukara sector, the FGD involved a group of 8 girls and in Rwinkwavu a group of 8 boys.

Moreover, one HT and two STEM and ICT teachers from the school hosting visual impaired students were interviewed. In total this study involved 10 HTs or DHTs from 10 schools; among which 3 females and 3 DHTs; 19 teachers with 10 teaching ICT and 9 teaching STEM subjects.

Table 2: Overview of participants in the needs assessment

Participant	Type of interview	Number of Respondents	%Male participants	Average age	Average years Job of experience
DEO	In-depth interviews	1	100%	NA	NA
SEIs	In-depth interviews	2	50%	NA	NA
HT/DHT	FGDs	9	80%	NA	NA
	In-depth interview*	1	100%	NA	NA
STEM and ICT teachers	FGD & Scratch exploration Assessment	17	100%	31	4
	In-Depth interview*	2	50%	33	6
	Self-assessment	30	93%	NA	NA
Students	FGDs	16	50%	17	NA

* This was done for HT and Teachers from the school in Gahini.

In addition to the 17 ICT and STEM teachers selected for FGDs, to pilot test the Scratch pedagogical guide, 7 STEM School Subject Leaders (SSL) from Kayonza that participated in the University of Rwanda - college of Education (UR-CE) and VVOB Educational Mentorship and Coaching for STEM (EMC-STEM) programme were selected based on their high performance in the programme. The 7 STEM SSL were then asked to attend the pilot testing workshop with one ICT teacher from their school. One STEM teacher could not attend the session. Therefore, 13 STEM and ICT teachers that participated in the pilot test of the Scratch pedagogical guide were included in our sample, resulting in 30 respondents for the self-assessment survey. Table 3 provides an overview of the types of assessments, study instruments, and sampling of this Needs Assessment Study.

Table 3: Overview of assessments, instruments, and sampling

Respondents	Study instrument	Sample	Research objective
DEO	In-depth interviews	The DEO in charge of secondary and TVET education and 2 SEIs from the selected sectors.	Assessment of required conditions at school, sector, and district level to ensure that Scratch can be integrated into STEM/ICT classes and after school clubs.
SEIs	In-depth interviews		
HT/DHT	FGDs or In-depth interview	All Head teachers from the 10 schools participated. N=10	
STEM and ICT teachers	FGDs or In-depth interview	2 teachers from all the selected schools, one of ICT and the other one for STEM. N= 19	
	Scratch exploration Assessment		Exploration of experiences and attitudes of STEM, and ICT teachers regarding coding.
	Self-assessment	N=30 (i.e., Participants from FGD data collection and 13 ICT and STEM teachers that participated in the piloting of the pedagogical guide)	Assessment of ICT skills and knowledge of STEM and ICT teachers on ICT hardware, applications, and safety precautions.
Students	FGDs	N=16, 8 students from 2 needs assessment venues. In one school female students and male students in the other.	Exploration of experiences and attitudes of students regarding their learning experience at school, extra-curricular activities and ICT.

Analysis

All FGDs and in-depth interviews were recorded, and recordings were transcribed ad verbatim by a research assistant. Transcriptions were imported into the qualitative analysis software DEDOOSE where all interviews were coded thematically using the themes described in the data collection tools as well as newly emerging themes. To assess the importance of different findings, frequency and extensiveness of codes and themes were assessed in DEDOOSE. However, given the few schools that were included, all themes, whether major or minor, were considered for this report.

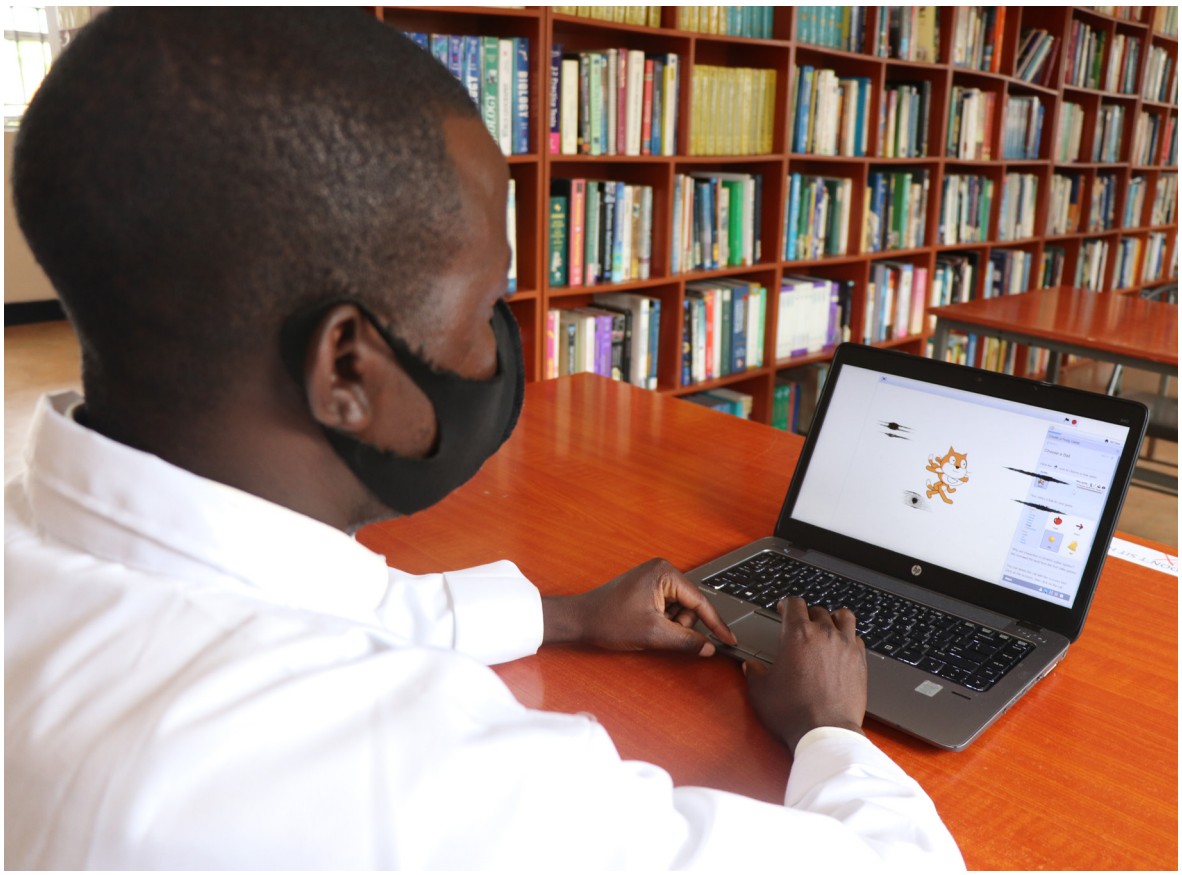
Data from the paper-based self-assessments were entered into a spreadsheet file and analysed using Stata. A T-test was applied to see if there is a statistically significant difference between the mean scores of ICT teachers and the mean scores of STEM teachers.

Ethical considerations

Prior to each interview and FGD, interviewers explained the purpose of the needs assessment and their rights and participants were invited to ask questions. Voluntary written informed consent was requested from all the participants. Interviews with students were conducted by a researcher of the same gender. The HTs of the hosting schools were asked to sign the consent forms of their students as they were younger than 18 years; this is common practice in Rwanda, given the close relationship between parents and the HT.

Methodological limitations

This needs assessment had some methodological limitations. Given its operational nature and programmatic goals, the study mainly relied on qualitative research techniques with small samples of purposively or conveniently selected respondents. Given this design, the study is therefore not representative for all secondary schools in Rwanda and generalizing results to other settings should be done with care. In addition, researchers and the research assistant involved in the study were all VVOB staff members which may have introduced some bias during the interviews and the analysis of the results.



Findings

Characteristics of schools in Kayonza district

The Scratc[2]h 2050 project will require access to ICT infrastructure, and it was in this line that this study aimed to assess the characteristics of secondary schools in Kayonza. While this needs assessment was conducted, Kayonza counted 45 secondary schools, each unique and diverse. This data is based on available national data and confirmed by local education leaders during the discussions. Table 4 provides an overview of the characteristics of secondary schools in Kayonza. First, in terms of school financing status, 35 schools are public schools (including 5 boarding schools), and 10 private schools (including 3 boarding schools). In terms of school type, 9 schools are secondary-only; among which 1 host also students with visual impairment; while 22 are 9-Years Basic Education schools (offering primary 1 to senior 3) and 14 are 12-Years Basic Education schools (offering Primary 1 to Senior 6).

In addition to the 45 secondary schools, the government of Rwanda[7] is financing together with the World Bank as part of the Project for Quality Basic Education for Human Capital Development[8] the construction of new classrooms and latrines across the country to address mainly travel time for students and overcrowding in basic education. The constructions started in 2019 and during school closure the project further extended across the country into a mass school construction program to accommodate children by the reopening of schools. During the discussions it was mentioned that Kayonza will have 3 new schools and 7 schools that will be upgraded as of 2021, 6 upgraded from primary level to S3 while 1 will be upgraded from a 9 YBE school to a 12 YBE school, resulting in a total of 54 general secondary schools.

Table 4: Characteristics of secondary schools in Kayonza district

	School status				New schools		
	Public		Private				
	Boarding	Day school	Boarding	Day school	Upgraded to 9 YBE	Upgraded to 12 YBE	9 YBE
Number of schools	5	30	3	7	6	1	3
% Access ICT	100%	50%	100%		0%	0%	0%

In terms of access to infrastructure, 38% of the 45 schools do not have access to grid electricity but some of these schools have access to a solar panel. According to different study respondents, most public schools do not have access to a science lab, except for some boarding schools. And according to national education data 67% of the secondary schools in Kayonza have access to a SMART classroom. REB has provided 100 laptops to all schools with SMART classrooms for teachers and students and during the discussions with different participants it was highlighted that schools without SMART classrooms have at least 5 to 10 computers for the staff.

> "In terms of accessing ICT infrastructure, all schools with a SMART classroom, REB makes sure that they have a server, Positivo laptops and a projector. And up to P4 students have access to the One Laptop Per Child (OLPC) laptops. Local education leader"

Depending on the number of SMART classrooms per school (i.e.:1 or 2), a teacher is in charge of monitoring and attending students and teachers in the SMART classroom. In every school there is at least one ICT teacher with a background in ICT and another teacher should be selected among the other teachers to

[7] MINEDUC (2020). Towards achieving adequate school infrastructure and equipment. Accessible at: Towards achieving adequate school infrastructure and equipment (mineduc.gov.rw)

[8] World Bank (2019). Rwanda Quality Basic Education for Human Capital Development Project. Accessible at: World Bank Document

support him/her. The selection of the second teacher should be based on his/ her personal interest in ICT and motivation to support others.

While access to ICT infrastructure is still challenging in secondary schools, some good practices were mentioned in this Needs Assessment. Collaborations were set up between schools with no access to ICT or science lab and nearby schools in order that students from these schools get an opportunity to practice with laptops or science equipment, at least once per term for all classes with priority to S3 and S6 students since they have to take an ICT and STEM subjects practical exam during the national examination. The best performing teachers[9] are rewarded with a laptop or tablet by REB.

In this regard, SEIs and District officers work together with REB to identify the needs of schools in terms of ICT infrastructure and coordinate and direct the implementation of different projects from development partners. The partners mentioned during the discussions included VVOB, AIMS, KOMERA and SOMA UMENYE who are active in improving STEM education in the district and Imbuto foundation supporting in access to ICT tools.

STEM Education

Participants were asked how they see the situation in Mathematics, Physics, Chemistry and Biology. It was highlighted by SLs and local education leaders that STEM teachers are usually graduates from the university and they mentioned that there is no problem finding a teacher with the adequate qualifications. However, students were for the opinion that some teachers lack pedagogy skills and interest in teaching which impacts the performance of students in these subjects. In terms of performance, STEM teachers were of the opinion that O-level students perform better than A-level students and students from boarding schools perform better than students from non-boarding/day schools. The reasons given by teachers are that high performing students are oriented to attend the boarding schools and also boarding schools have bigger budgets to motivate teachers.

> "I like biology and ICT.…. I like both subjects because of the teachers, both teachers' pay attention to us and they explain how we can use what we learn in our daily life. They consider us like their own children. 16 years old, Male student"

The negative perceptions about STEM education mostly arose from the fact that students still perceive these subjects as difficult. SLs, SEIs and district officers mentioned that they work together to raise awareness on the advantages of studying STEM subjects.

> "We are all different and we all have subjects we prefer and that we understand better than others. Sometimes, you will find a boy with whom you like the same subjects but in general girls do not like math, only a few does. For math and other science related subjects. Girls most of the time like subjects such as history, and Kinyarwanda mostly subjects that are quite easy. Some girls say that when you study combinations with science subjects you are always studying and have less time to do anything else. On average 50% of girls are interested about science subjects while it is 70% for boys. 17 years old, Female student"

ICT Education

According to local officers and HTs, ICT has not yet been integrated well into education (i.e., teaching and learning ICT as a subject). This is mostly driven by limited access to ICT infrastructure as some schools do not have ICT infrastructure for all teachers and students to use. Students; mostly boys; are quite enthusiastic about using ICT tools and that they tended to grasp ICT skills more easily than teachers.

[9] Every year, at the International Teachers Day REB award the best performing teachers in every district to recognize their contribution to delivering quality education. REB judges basing on skills in preparing lessons, teaching, marking and correcting learners, commitment to the job, in addition to interpersonal skills. http://www.hope-mag.com/index.php?com=news&option=read&ca=1&a=1555

Although, teachers have more exposure to ICT devices than students; whether it is a smartphone, tablet, or a computer, whereas for most students, the only opportunity to be exposed is at school. Overall, a number of students only learn ICT in theory and have no practical skills. In addition to that, ICT teachers have low access to trainings in ICT or coding.

> "I am teaching ICT theoretically because there are no material and even the learners from our school, they like so much ICT, but they are unhappy to learn ICT without access on materials. They are not typing, they are not watching some videos on the projector, we are using more theories than practices. Teacher Rukara."

Clubs

During the discussions, all participants were asked about the access and availability of extra-curricular activities. It was highlighted that schools in Kayonza have different modalities for extra-curricular activities or clubs, out of the 9 schools visited 8 had after-school activities. Participants mentioned different clubs including clubs on ICT, media, environment, unity and reconciliation, hygiene, Itorero program, science, fighting against HIV-AIDS, languages, etc. These clubs are usually organised on a weekly basis. Every school has different clubs, and a different day is allocated to club activities. It was highlighted that given that most schools are located in rural areas, schools prefer to leave a time slot in the timetable from 3 PM-4:20 PM for these activities. This accommodates students and teachers, who often need to travel far to their home. Boarding schools have more flexibility and can organize these activities even during the weekend.

> "In day schools, the clubs are not organized every day and take place after classes. Because taking an example of a club that would mix O-level and A-level students, in O level it is complicated to find a free time on their timetable so the only way we do it is to plan for one day after school for all club activities. In boarding schools that is where it is possible to have different club activities planned for different days. School leader, Rukara."

These clubs are supervised by a teacher and a student is elected as a club leader. Students mentioned that they participate in clubs because it is an opportunity to increase their knowledge and to exchange with their peers and teachers, which is not always possible in class. Participation in these clubs differs, mostly depending on the characteristics of the clubs. For instance, in ICT clubs a lot of students participate but in schools with no access to computers these clubs are more theoretical and therefore less interesting for students. In clubs like the media club, the participation depends more on the student's self-confidence. Nevertheless, in general it is important for teachers in charge of these clubs to be motivated and to raise awareness among students about the benefits of taking part in the specific after-school club.

> "In science clubs we perform different activities or experiment. From what they have learnt in theory to put it into practice, or we discuss about some important scientists like Newton, the law of gravitation or any other subject. Teacher Rukara."

In terms of support from parents, it was underlined that in general, parents are quite positive about their children attending after school activities. However, clear communication on the modalities and advantage of the activities are deemed important. All activities are organized at school level, the sector and district officers came in to support inter-school competitions with HTs taking the lead to organize them.

Experience learning and teaching with ICT

From the in-depth interviews and FGDs with participants, it was highlighted that even in schools with access to a SMART classroom, the use of ICT for teaching is low. Although in all schools it is planned that all teachers can use the SMART classroom for their lessons, in reality the use of ICT is determined by the affinity and expertise of the teacher in using ICT tools.

> "Not all teachers use ICT while teaching, but in our sector, we have for example this teacher, he teaches ICT and chemistry, he was the most performing teacher last year. This teacher most of the time he does not say that I need this or that book or lab material/product he will use a video (i.e.: Using a computer and Projector) to show students how product combinations are done. He is the one training others in using technologies for teaching during CPD programs, and he heads the forum of ICT teachers in the sector. So, for example, if it is a new material to be used in lab, he will show other teachers how the material can be used from a video. Local education leader"

Nevertheless, there are some examples of teachers who use ICT in their lessons. Students mostly mentioned STEM teachers as the ones that are using ICT in their lessons; mostly because there is room in the STEM curriculum content to explore other teaching methodologies. For instance, in the absence of a science lab chemistry and Physics teachers can present experiments using YouTube videos. Overall, STEM and ICT teachers use projectors and their computers during their lessons. On the other hand, few participants mentioned that they are using emails and WhatsApp to send tests/quizzes or notes to their students. Students mentioned that they can communicate and exchange on their lessons using social platforms (i.e., Facebook).

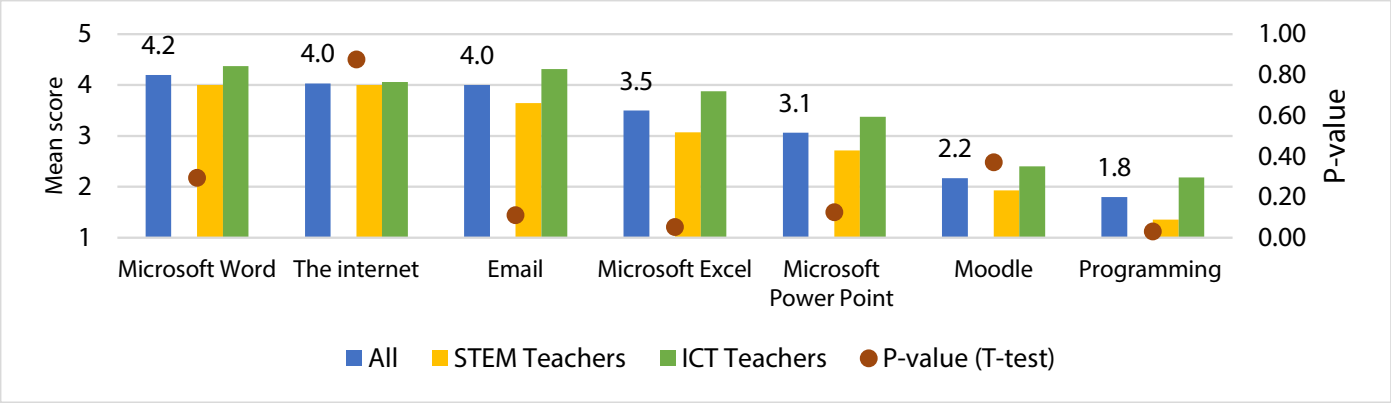
> "For chemistry lessons, given that we do not have a chemistry lab at school the teacher consult uploads a YouTube video on how to use a litmus paper for instance and the teacher project it to show us what happens when you put an acid on it. So, we are able to see and understand why red can turn to blue better than when explained without the video. 17 years old female student."

To motivate teachers in Kayonza to use more ICT in their lessons, the district organizes competitions for the teachers' day and presents the best practices of teachers. The teacher that was rewarded last year (2020) was a primary teacher that created a website to help his students to continue learning during the lockdown period. At sector level, the SEI supports schools that are lagging behind by monitoring digital literacy during inspection activities in schools.

ICT knowledge and skills

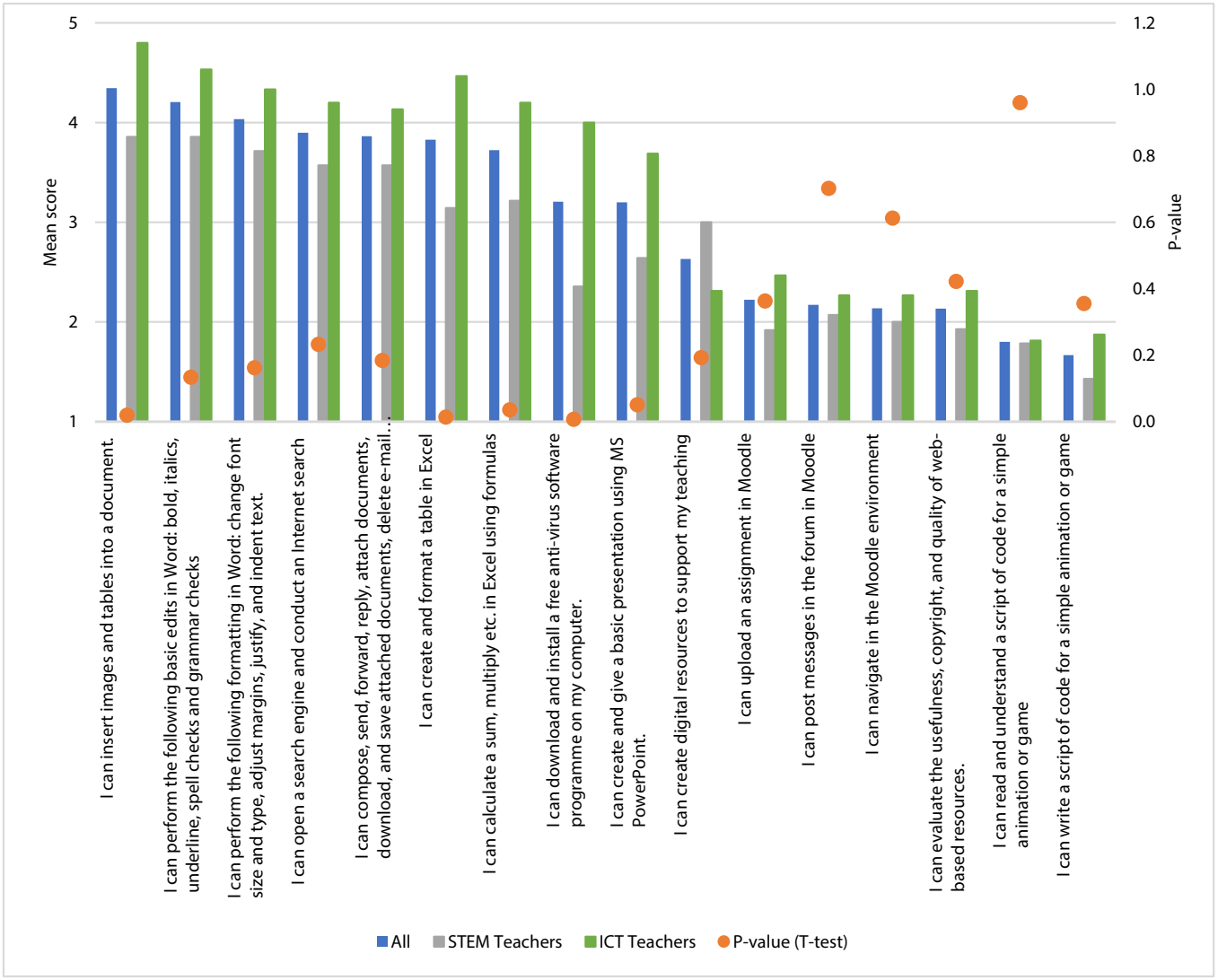
In the self-assessment survey, STEM and ICT teachers were asked to rate their knowledge on different applications, Overall, teachers are less confident in using Moodle and programming although than using Microsoft word and internet there are large differences among individuals (i.e.: Standard deviation of 1.4 and 1.1 respectively). Considering the confidence scores of teachers that teach ICT or STEM subjects (see Figure 1), ICT teachers score their confidence higher than STEM teachers, although the difference is only significant in programming skills ($p\text{-value}<0.05$).

Figure 1: Comparison of confidence about using applications disaggregated by subject taught (Mean scores) N=30



Looking more specifically at the kinds of skills; teachers rated their skills from: 1. I have no ability at this; 2. I have an idea how I can do this; 3. I could probably do this with trial and error; 4. I am comfortably proficient at this; 5. I am a master practitioner at this. The self-reported score by teachers on ICT skills varied according to the type of application used; with skills in using Moodle and programming being lower (See Figure 2). ICT teachers again score their skills higher in all aspects. The difference was significant for the ability to insert images and tables in a document, creating and formatting a table in Excel, calculating a sum, multiply etc. in Excel using formulas, creating, and giving a basic presentation using MS PowerPoint and downloading and installing a free anti-virus software programme on a computer.

Figure 2: Comparison of ICT skills disaggregated per subject taught (Mean scores) N=30



During the Scratch exploration Assessment, teachers were given an introduction to Scratch and asked to follow in 45 minutes a set of guidelines to explore Scratch. The goal of the activity was to assess their ability to explore Scratch environment following few guidelines and to assess their attitudes towards learning something new. It was expected that teachers would not complete all tasks but would try to follow the guideline and would be able to collaborate and discuss together to complete the tasks. Overall, 9 out of 17 of STEM and ICT teachers (53%) did not manage to do anything in the exercise. Mostly because they had difficulty in using a computer (i.e., 6 out of 9). The rest of the teachers (i.e., 8 out of 17) managed to create their account in Scratch but fewer managed to navigate the interface to add a sound to the image in Scratch (i.e., Sprite: An image on a Scratch computer program screen. Every Scratch program is made up of sprites and scripts that control them. Scripts are programmed to make sprites do things.), change the colour of the background and/or figure out how to get help with blocks (i.e., Blocks: Blocks are puzzle-piece shapes that are used to create code in Scratch. The blocks connect to each other vertically like a jigsaw puzzle.) Overall, the ability of teachers to perform the different assigned tasks were driven by their capacity to use a computer and their attitudes towards exploring the scratch platform. This study did not identify large difference in the ability of ICT teachers compared to STEM teachers.

Attitudes towards the implementation of Scratch in Kayonza

During the focus group discussions, Scratch Overview Video on Vimeo an introductory video of Scratch was presented to HTs, teachers and students. Interviewers then asked what participants thought about the implementation of Scratch in STEM and ICT lessons and in after class activities.

Including Scratch in ICT and STEM lessons

All participants acknowledged that it would be interesting to include Scratch in ICT and STEM lessons, mostly because Scratch is fun, and would help increase digital literacy and coding skills and would help teachers to think out of the box.

> "Scratch will help us as ICT teachers and science teachers to create more diversified learning materials and to make environment of learning more comfortable and more visual. Teacher Rwinkwavu."

In addition, it was highlighted that if teachers are provided with computers, they can use them during the lessons and if they are trained on Scratch, that there should be no problem in including Scratch in lessons. Most importantly, that is also in line with the government's strategy on supporting teachers to improve their digital literacy skills so that they can integrate ICT in their classes and in remote teaching programmes during school closures.

> "The focus we have now in general is to promote teaching and learning using technologies. So that a student does not consider a telephone as a tool to call only but a tool where he can also find courses, a computer not to be used to write in word only but can be also used to access some learning materials from REB website. So, for us, this decreases the movements to distribute and pickup teaching materials, they will then access everything from the SMART classroom. Local education leader"

Implementation of after-school Scratch clubs in schools

Students were enthusiastic to learn about ICT and were already picturing how Scratch could be used in their lessons in the same way as they are using ICT in their lessons.

> "For me I would like to understand the aquatic life, you know how all animals live in harmony together without killing one another. Using Scratch will help me show in my community or to my colleagues how people can live in harmony as well respecting each other's differences. So, you can use Scratch to show that one-person can-do hunting for a living without necessary stilling his neighbour's goats. 16 years old, male student."

The implementation of after-school Scratch clubs in schools was said to be more complicated mostly in terms of planning. For schools without clubs, the school timetables are overloaded which leave little time for any extra-curricular activity. While for schools that already have clubs, the after-school club can be organized during the same period as other clubs. However, these schools face other challenges; for clubs to be operational, students should have access to computers. Therefore, even in schools with access to a

SMART classroom and given the sanitary and social distancing measures that are currently implemented there should be a maximum number of students that participate in a club.

> "So, I think that for me I would separate from class to another class may be senior one apart, senior two apart, because even the skills they have on using a computer are different. Teacher Rwinkwavu."

Moreover, it was highlighted that for a club to be successful, HTs are to play an important role. Both in terms of planning and monitoring the activities of the clubs and to raise awareness of their benefits among parents.

Gender and Inclusion in Kayonza

During the Needs Assessment, special attention was paid to incorporating gender and inclusion into the data collection by ensuring that both men and women took part in the FGDs and by asking specific questions about gender and inclusion of vulnerable groups. One school hosting blind children was also included in the Needs Assessment.

Gender

In terms of gender, it was often mentioned that girls fear STEM subjects mostly because of the perception that these subjects are difficult. But that once they are interested in learning these subjects, they perform well. Moreover, it was also mentioned that it is still challenging to find have STEM and ICT female teachers because of the same old perception.

> "This concerns teachers as well, where considering female teachers. Based on the untrue perception that STEM education is meant for boys you find as well fewer female teachers teaching these subjects. For instance, in the sector we have around 4 STEM female teachers. Local education leader"

Another theme that came up was that the decision of students to study these subjects depends on one's motivation and determination. Therefore, SLs and local education leaders make sure to advocate and promote girls in STEM on a regular basis starting from parents.

> "It depends on the person; they are some who like biology or chemistry and others that like history but there are some girls who are also interested in these subjects as well. Mostly in ICT, because nowadays it is important to know how to use technology, so they put an effort in learning ICT. In terms of performance, you will find that 50% of the higher performer in ICT are girls. 16 years old male student"

When it comes to ICT, both girls and boys have the same level of access to ICT tools, however, it was mentioned that boys and girls tend to use ICT quite differently; in the sense that having been taught the same concepts boys tend to be more predisposed to explore further the aspects learned than girls.

> "During ICT lessons all students go to the SMART classroom. However, after the lessons, even if the rooms are stills open to everyone interested, you found most of the time more boys than girls. Head teacher, Rukara."

Disability

The discussions with the HT and STEM and ICT teachers from the school hosting students with visual impairment highlighted that the school host 864 students among which 0.6% of students are physically impaired and 2.5% students are visually impaired separated by students with low vision and total blindness. Teaching low vision impaired students requiring only increasing the size of certain words while for students with total blindness all learning material have to be translated in braille or narrated. In general, the school has different facilities enabling visually impaired students to follow classes, including braille machines, audios devices, headphones, books interpreted in braille, braille printer, etc. For exams, they are assigned a different exam, translated in braille as well. When they sit for national exams, the exams are translated as well.

In terms of qualified teachers, it was assured that the school has experienced teachers trained or having a

notion on teaching visually impaired students. In addition to that the school has 2 full time staff allocated to making sure that blind students have access to braille translated learning materials and support going over their lessons after class.

> "As a teacher, when you are teaching a class with students with total blindness you make sure that during the lessons you give them a special attention. In the sense that instead of asking students to look at this or that you make sure that you prepare additional solid materials that they can touch or use other senses than vision. Male teacher."

In terms of STEM subjects education, the main challenge faced by total blind student is that they cannot access practical lessons or exams. In the sense that for instance when asked to compute something it requires to read the sentence for them and give them the opportunity to answer vocally, which is not possible for practical exams. Therefore, blind student can hardly pursue STEM combinations in A-level and have low performance scores in S3 national examinations in these subjects compared with other students.

In terms of ICT education, it was assured that all students have access to the lessons. The school has 4 talking machines, and a narrating software is installed in all computers in the SMART classroom and blind students use headphones during ICT classes. When it comes to using ICT during lessons, the teacher can count on students assigned to fellow blind students to support them during lessons to make sure that they explain what is projected and the teacher will take the time after the lesson to follow-up directly in case the student missed anything.

Lastly, considering physical disability, for instance, in all secondary schools; SEIs make sure that during their classroom inspections that they check that the blackboard is not too elevated, that tables and chairs are at adequate height and that classrooms are accessible. This includes the accessibility to tables and chairs in the SMART classrooms.

Discussion, conclusions and Recommendations

The objective of this needs-assessment study was to identify the key priorities and strategies that will inform the planning and implementation of the Scratc^{2}h 2050 project. The study involved interviews with local education leaders including the District Director of Education and Sector Education Inspectors and school members (HT/DHT, ICT and STEM teachers and students) to understand the situation, to identify good practices and challenges regarding ICT and STEM education, and to assess the potential for implementing Scratch coding clubs in Kayonza. In addition, the aim was to assess the baseline situation that will inform further refinement of the project.

Enabling environment

This need assessment showed that in Kayonza there is a lot of variation among secondary schools in terms of access to infrastructure, levels of ICT and STEM education and availability of an enabling environment for Scratch after school clubs. Some secondary schools have no access to grid electricity but have access to solar panels that can power a limited number of devices. Boarding and private schools have better access to infrastructure such as SMART classrooms. To decrease the distance to school and overpopulation in classrooms, new schools were built, and some existing schools were upgraded to host O-level students. These newly built schools are worst off because they still lack a lot of teaching materials and do not even have access to electricity.

It was also indicated that there were still some challenges in terms of ICT and STEM education, in the sense that ICT as a subject is still limited by the low access to ICT infrastructure and the fact that ICT teachers have few opportunities for training. The challenges in STEM education were explained by the fact that few schools have a science lab, and students, mostly girls, still perceive these subjects as difficult. It was also pointed out by students and school leaders that STEM teachers although quite knowledgeable about the content of their lessons still lack pedagogical skills. In addition, there were differences between schools whereby boarding and private schools are better off compared to other schools. Nevertheless, the government and local level officers are working with school leaders to raise awareness on the benefits of studying these subjects (i.e., ICT and STEM). The self-assessment survey showed that ICT and STEM teachers have relatively low ICT skills when it comes to using Moodle and in programming and better skills in internet navigation and Microsoft word and that ICT teachers are slightly more confident about their ICT skills than. Lastly, the Scratch exploration exercise showed that the attitude and ICT skills are quite necessary provided that teachers will be learning a new skill.

For the further planning of the Scratch trajectory for teachers, it is important to consider the following:

- The selection of teachers to participate in the project should be driven by their motivation and interests.
- How teachers from new or upgraded schools will be involved in the project; this means that they will need to benefit from the distribution of laptop as well.
- Provide a digital literacy training with specific attention for learning online using Moodle before the learning trajectory.
- Integrate gender and inclusion in the learning trajectory.
- Purposely target female STEM and ICT teachers

Including Scratch in ICT and STEM lessons

This needs assessment revealed that the use of ICT in teaching is still low, mostly because of low access to ICT infrastructure. In schools where ICT infrastructure is available the use of ICT tools in teaching is mostly driven by the affinity and expertise of teachers and it was highlighted that mainly STEM teachers use these tools in their lessons compared to other subjects teachers (i.e., ICT teachers not included). In addition, resulting from the school closure, there is a high demand from teachers for training in using digital technologies for teaching remotely. This to make sure that in the future students can continue learning remotely. Moreover, teachers are highly performing teachers are rewarded by REB with a laptop or a tablet.

Integrating Scratch in ICT and STEM lessons is not likely to bring about any challenges after teachers have been trained. However, teachers in schools without SMART classroom will still need additional tools such as a projector. It was also recommended that the content to be used during coding clubs should be adapted to the level of students for more impact.

After school Scratch clubs

This need assessment showed that some secondary schools in Kayonza already organize after-school activities. School leaders plan a time slot in the timetable while teachers have the lead in raising awareness and monitoring the clubs. This result in varied modalities for after- school activities in terms of the day chosen by the school but all schools assign the last hour to club activities; at least for day schools. In boarding schools, teachers have more flexibility because they can organize activities at any time during the weekend. In terms of participation, students participate highly in clubs and have the support from their parents as they assume that students learn a lot in these clubs. It was also highlighted that the challenge of access to ICT for students will influence a lot the setup of clubs.

To facilitate the implementation of after school Scratch clubs in all secondary schools in Kayonza, the following is recommended:

- Communicate clearly on the benefits and modalities of clubs to parents and students; including organizing event for school leaders (i.e.: HTs and parents committee) and integrating communication in the trajectory for teachers.
- Clarify the modalities of the clubs (i.e.: Minimum participants, period on the timetable); here it can include developing a poster that teachers can use to communicate about the clubs in their schools.
- Allow room for flexibility for schools to adapt the planning for after school clubs. And organize platforms for School leaders and teachers to share practices.
- Set-up the clubs per level (i.e.: O-level or A-level), this because students have different ICT skills. Or per year, depending on the school context. Clarify to all actors that clubs will be organized each semester. Not all students will be able to join in the first cycle.

Gender and Inclusion

It was highlighted in this needs assessment that STEM subjects are still perceived as subjects for boys; on the one hand with girls hardly choosing STEM combinations in A-level and on the other hand still challenging to find a STEM female teacher. Although girls are more enthusiastic about ICT compared to STEM subjects, boys tend to apply and explore further different aspects learned in class than girls. Considering, visual impaired students it was underlined that the design of STEM lessons and assessment is not enabling enough for visually impaired students to pursue STEM combinations in A-level. Nevertheless, it is possible for the schools to create an enabling system /environment to support visually impaired students in accessing ICT lessons.

To enable a gender and special needs inclusive environment in the Scrat^{2}ch project the following is recommended:

- Request school leaders from secondary schools to select at least 1 female STEM or ICT teacher to take part in the learning trajectory.
- Agree with school leaders and teachers that at least 50% of coding clubs members should be girls.
- Include gender and inclusion in the Scratch learning trajectory for STEM and ICT teachers with attention for gender stereotyping practices and classroom strategies to achieve gender equity and inclusion.
- Collecting gender and special needs disaggregated data on club participation and outcomes.
- Include in the programme one ICT teacher who is experienced in teaching ICT to visually impaired students as the teacher can help find innovative ways to make sure that visually impaired students are included and have the necessary support when participating in the afterschool Scratch clubs.

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