

Facing the effects of COVID-19 on Grade-12 students' education: A focus on science and mathematics instructions

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Abstract

This study intends to investigate the effects of the COVID-19 pandemic on Grade 12 students' education, focusing on sciences and mathematics instructions, during the lockdown and after secondary schools reopening on 2nd November 2020 in Rwanda. The study also seeks the potential solutions to the challenges caused by this pandemic. This is a mixed research design that used both qualitative and quantitative approaches to collect data. Thus, 113 participants including 108 Grade 12 students, three directors of studies (DOSs) and two science teachers were purposively selected and used in this study. Semi-structured interviews were used to collect data from DOSs and teachers. Besides, a survey questionnaire was used to collect quantitative data from students. Thematic analysis was used to analyze qualitative data, while quantitative data was analyzed using percentages generated by Microsoft Excel 10. Results from this study revealed that students experienced learning loss during the lockdown period. The remote learning strategy adopted by Rwanda Education Board was not effective due to the lack of parental guidance, monitoring, and financial support. Some students were found preoccupied with household chores, while others embraced different jobs. Girls were involved in sexual exploitation and early marriages, which resulted in school drop-outs. Students' performance in science and mathematics has reduced. Talking to students, using extra hours, and preparing various assessments are some of the strategies being used today to mitigate the experienced learning loss. Hence, there is a call for educationists to take educational measures considering the effects of COVID-19 on students' academic, social, economic, and psychological perspectives for students' performance and lifelong learning.

Keywords: COVID-19, drop-out, Grade 12 students, Rwanda, science and mathematics, students' performance

Introduction

Based on the current literature, little is known about the impacts of COVID-19 on learning for the projections of the potential learning strategies needed to predict the future. Also, educational leaders have little data about how much learning has been affected by the school closure due to this pandemic (Kuhfeld, Tarasawa, Soland, Johnson, Ruzek, & Liu, 2020). Reference made to the current study conducted by Rwigema (2021) on the impact

of COVID-19 lockdowns on the education sector that takes the case of Rwanda; the results show that COVID-19 had negative effects on education including, learning disturbances and limited access to education and research facilities. It was noticed that students from less advantaged backgrounds can experience more significant learning loss during this emergency period than their more advantaged counterparts. This may be due to differences in non-financial parental support,

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parental financial resources, schools attended, and students' digital skills (Pietro, Costa, & Karpiński, 2020, p. 12). Even if the COVID-19 vaccine is being given for many countries whereby the world is becoming safer, measures need to be taken to stop long-term legacies of the pandemic, that is rising inequalities that are choking students' learning (Save the Children, 2020). Therefore, there is a risk that the problems short-term inequality brought about by COVID-19 may persist over time and leads to economic disparities if the urgent appropriate measures and policies are not taken in time (Pietro et al., 2020; Save the Children, 2020).

It is hypothesized that COVID-19 would harm students' performance, most especially in science and mathematics, students' school attendance, and students' psychology (Sintema, 2020). That is why school leaders and educationists are called to think about and implement adequate strategies to recover the lost learning as soon as students are back to school (Tadesse & Muluye, 2020). There is a hope that the experience gained from the pandemic of 2020 will shed light on the generation of new laws, regulations, platforms, and readiness for dealing with the unpredicted future cases, whereby the governments and the citizens will be more alerted than today (Basilaia & Kvavadze, 2020).

Therefore, it is undeniable that the findings of this study will contribute to the current educational situation affected by Coronavirus, to fight the problems that it caused and to make students learn effectively (Putra, Liriwati, & Tahrim, 2020). Furthermore, there is a need to look at the current situation, the students' psychological, social, and academic perspectives after school reopening to help students feel actively involved in learning. To this end, the adverse effects brought about by COVID-19 will be mitigated to expect future

students' improved performance in future assessments.

When structuring this paper, we reviewed the available literature about the effects of the COVID-19 pandemic on students' education, explored the methodology, and presented the results, followed by their discussion, conclusion, and the implications for further studies have also been highlighted.

Effects of covid-19 pandemic on students' education

The reviewed literature showed that with the abrupt closure of schools, the decision made by different governments on the globe to avoid the spread of the COVID-19 pandemic impacted negatively on students' lives and learning.

Students' learning loss during lockdown period

Coronavirus (COVID-19), also known as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) originated from Wuhan city in China, ravaged the whole world Rwanda inclusive. Many countries closed schools from mid-March 2020 up to the end of the year 2020 intending to reduce the spread of this pandemic. Despite being uncertain, this decision was made despite being uncertain that the school's closure is an effective measure to control this pandemic spreading (Svaleryd, 2021). With the physical schools' closure, students experienced learning loss (Kuhfeld et al., 2020). First, students in quarantine tended to misuse their time compared to when they were at school. Secondly, students were psychologically affected by the quarantine they were in, and therefore felt stressed and failed to concentrate on their studies. Third, students at home felt lonely, demotivated, and was unable to engage alone in learning activities (Akat & Karataş, 2020; Pietro et al., 2020). Indeed, schools do not only provide students with the opportunity

to learn, but also they are the conducive places where they can access mental health care services and a place where students can interact and play with friends (Save the Children, 2020).

It is evident that with this school closure, student-teachers contact hours were limited. For this reason, mathematics and sciences will mostly be affected since these subjects require students' concentration to understand the scientific concepts, doing experiments and exercises. Moreover, sciences and mathematics were reported to be difficult (Ukobizaba, Ndiokubwayo, Mukuka, & Uwamahoro, 2019), and they required students to use much time to learn them. Most significantly, students doing sciences and mathematics are expected to do lab experiments, whereby they have to practice during national exams. Unfortunately, students did not get time to conduct such investigations during the COVID-19 period. Therefore, there is a greater need for teachers to improve how they implement the curriculum and make it responsive to the needs of the students (Tadesse & Muluye, 2020; Toquero, 2020) today.

A learning loss was also recorded in Rwanda (Rwigema, 2021). Even though, the statistics of data collected within three schools on the percentages of students who got passing aggregates in science and mathematics to get

an advanced level certificate, showed that students passed these subjects effectively, taking into account the two previous academic years, 2018 and 2019. See Table 1 below.

Looking at the percentages of students who passed in the national examination for the academic years 2018 and 2019 in the three schools, there is a significant students' performance in biology, chemistry, physics, and mathematics, which is a good record (Table 1). For School One, biology and mathematics recorded a significant rise with +6.9 and +9.9, respectively. However, chemistry got a drop of -1.2. For School Two, mathematics recorded an increase of +0.4. For School Three, chemistry and mathematics recorded a significant rise of +1 and +12.5, respectively. However, a drop was recorded in biology and physics with -0.9 and -1, respectively. Consequently, there is a fear that the levels of these students' performance will dramatically drop further in the 2021 academic year if the effects of COVID-19 are not addressed adequately and timely.

The link between COVID-19 pandemic and school drop-out

Currently, the ministry of education (MINEDUC) in Rwanda communicated on national media on 30th March 2021 that 5% of the students did not come to school after schools are reopened. As it was introduced by

Table 1 The results analysis of students who passed national exams in sciences and mathematics in 2018 and 2019

Schools	Subject	Performance in 2018	Performance in 2019	The difference in rising/drop
One	Chemistry	97.9	96.7	-1.2
	Biology	91.7	98.6	+6.9
	Mathematics	82.4	92.3	+9.9
Two	Mathematics	53.4	53.8	+0.4
Three	Chemistry	99	100	1
	Biology	100	99.1	-0.9
	Mathematics	78.1	90.6	+12.5
	Physics	100	99	-1

Source: Primary data

Rwigema (2021), the reports showed that in the past eight months of COVID-19, 424 girls were impregnated in only the Northern Province of Rwanda. It was expected that the number could increase due to COVID-19 pandemic impacts that expose vulnerable girls to unprotected sexual intercourse. Indeed, Sabates, Akyeamong, Westbrook, and Hunt (2011) argued that experiencing poor health or malnutrition, child labor, poverty, and lack of motivation from parents and caregivers, are some of the sources of students' drop-out. Similarly, Save the Children (2020) and Tadesse and Muluye (2020) also reported that students were forced to work during the lockdown and contribute to the family's generating income since their families struggle to find what to share on the table. The adolescent girls were at high risks since they are likely to face gender-based violence, early pregnancies, and early marriages, resulting in cyclic poverty and the students' failure to fulfill their potentials since they automatically drop out the school.

When looking into the drop-out reports for Grade 12 students before the COVID-19 pandemic, no drop-outs are being reported in the academic year 2018 and 2019 (data collected from three schools). The government of Rwanda is committed to providing education for all to its citizens, whereby all children at schooling age are

seven up to grade 11 and 10 students from Grade 12 dropped the school during the COVID-19 period in the academic year 2020. See Table 2.

Challenges of remote learning during lockdown period

Although Governments around the world established and encouraged remote learning to sustain the educational services (Ozer, 2020) during COVID 19 period, this was not exploited as expected. The lack of network infrastructures, computers, and the internet, radio, and television has been a big problem for developing countries (Putra et al., 2020; Tadesse & Muluye, 2020). For instance, online learning in Rwanda was challenged by insufficient digital skills, poor infrastructures such as access to network connectivity, and a stable power supply (Rwigema, 2021). Similarly, many voices on the websites have been declaring that it was most challenging and difficult for students to learn from home. Some of the reported challenges are such as students were not prepared to use online learning technology, parents were not ready to support their children's learning, it was most challenging to monitor students' learning, and the governments were not ready to fully support the abrupt national learning policies during the pandemic crisis (Putra et al., 2020). Teachers themselves were not also ready for

Table 2 Secondary students' drop-outs report during the COVID-19 period in 2020

Schools	Grade 7-11 students	Grade 12 students	Total
One	1	2	3
Two	36	0	36
Three	0	8	8
TOTAL	37	10	47

Source: Primary data

called to access 12 Years Basic Education (12YBE). However, the data collected within the three secondary schools involved in this study showed that 37 students from grade

this new mode of delivery.

Methodology

This study employed a mixed study design (Creswell 2013) using a case study approach. Qualitative data and quantitative data were collected from teachers and students respectively for triangulation purposes.

Sampling and participants

The interview was used to collect data from five public secondary schools within Nyamasheke district, Rwanda. Three directors of studies (DOSs) and two science teachers were purposively selected and interviewed. The DOSs were considered for the study since they are technicians in monitoring and evaluating teaching and learning activities within their respective schools. Also, two teachers were taken for the purpose that they either teach sciences or mathematics, especially to Grade 12 students. Besides, a survey questionnaire was used to collect data from 108 Grade 12 students, purposively selected. Thus, 113 participants including 108 Grade 12 students, three directors of studies (DOS) and two science teachers were used in this study.

Instruments

The first author of this paper developed the semi-structured interview schedule and a questionnaire. The interview protocol was initially comprised of seven questions while the questionnaire was comprised of nine main statements, under which the sub-statements are ranked in five levels of Likert scales (strongly agree, agree, neutral, disagree, and strongly disagree) These two instruments were given to three experts. Two in mathematics education and one in physics education for review. All reviewers agreed on the seven questions to keep the instrument reliable. The reviewed versions were piloted to one DOS, a mathematics teacher, and one class of Grade 12 students in one school. During the pilot phase, a gap was found in the content validity. This led the author to add two

more questions to understand the problem on the ground clearly.

Ethical considerations

Before data collection, the researcher prepared the consent forms for participants, describing the aim of the study and for participants to sign and ensure their voluntary participation in the study. Besides, letters requesting permission to interview teachers and the DOSs and having a survey with students within the school were composed and addressed to the school leaders. The teachers and DOSs had to receive the interview protocols before the interview itself to allow them to prepare in advance since some interview questions required data from archives.

Data collection and analysis

Data were collected using two approaches. First, some participants were found at their workplaces where possible, and interviews were conducted using a smartphone recorder application. Second, when it was not practical to find participants at school, interviews were conducted through a phone call, and data were recorded with the phone recorder application and WhatsApp chats. Eight minutes on average were sufficient to end the interview. All the data collected were transcribed, and the coding was made for analysis. Member check technique that consists of giving back the verbatim transcripts to respondents so that they confirm if the transcription is of their original views was used. This was done to maximize the validity and reliability of the collected data. Besides, students were found in their classes. They were explained the purpose of the study before they voluntarily accept to participate in the study and fill the questionnaire. Thematic analysis was used to analyze qualitative data, while quantitative data was analyzed using percentages generated by Microsoft Excel 10.

Results

During the interviews, both Directors of Studies (DOSs) and teachers reported some cases of students' drop-outs because of COVID-19. Some reasons for these drop-outs are some students started running businesses and preferred to remain in those businesses or are employed in different jobs. Others, girls specifically, got pregnant, while others got married unofficially. In the three schools where data was collected, 10 Grade 12 students were reported to have dropped out of the school (see Table 2).

When asked how many Grade 12 [Senior 6 (S6)] students did not come back to school to resume their studies, and what might be the reasons why those students did not come back to school, the DOS at School 3 said: *"Three students dropped out because they were pregnant...For other two students, we do not know why they did not come back to school"* (Interview: 12th March, 2021). However, the physics teacher at school three has complemented and explained that some students dropped the school because of the businesses they have been running. He said: *"You find, a student has already done projects outside, then when coming back here, he finds that he is not making money, then, he drops and goes..."* (Interview: 12th March, 2021).

Another significant number of students, except those of Grade 12, also did not return to school to resume their studies. The reasons for dropping out given are the same as those stated above for Grade 12 students, including being pregnant for some, and others going to Kigali city and other parts of the country looking for jobs. In three schools, 37 (19 boys and 18 girls) students were reported to have dropped out (see Table 2).

Concerning strategies like using radios, televisions, and other platforms adopted by the Ministry of Education (MINEDUC) for students' learning during the COVID-19

period, both teachers and DOSs have reported that students did not effectively employ the remote learning established by MINEDUC while they were at home. Some of the reasons given are that students were much involved in household chores, while others do not have technological facilities like radio or television. However, it was noticed that a few students used remote learning. A Science teacher at School 1 reported:

Students used this remote learning but for urban students. In rural areas, students face problems like being involved in home duties and not getting time to learn. However, when we looked at the level of students when they were back to school, some students have used this remote learning approach. For instance, I teach Senior Six (Grade 12), even if the level of students has reduced, but it is not bad, compared to when that policy was not there (Interview: 11th March, 2021).

Once back to school, both teachers and students are experiencing difficulties that hinder effective learning. Students were reported to be tired of learning since they spent a long time at school after school reopening. Grade 11 and 12 students spent four months and a half at school before coming for the Easter holidays 2021. Students are also discouraged and are under stress that they can find themselves in another lockdown. Interviewed on how participants find the learning conditions of students during this COVID-19 period at the school, the DOS at School 1 replied:

At school, students are trying to learn. But when you look at other activities used to help us manage students to learn effectively like sports, entertainment, external visits, all those activities have stopped. The lack of these activities contributes greatly to disturbing students to learn effectively because students do not get time to pause and

relax. These can be reasons why some students feel disgusted or tired of learning, which can impact their performance (Interview: 11th March, 2021).

Furthermore, a Mathematics teacher in school 3 added:

...even if you see many are back, but the learning conditions we are in are difficult. For instance, wearing masks, keeping social distancing, and not learning in groups before Coronavirus disturb them. Before Coronavirus, students used to sit together with their colleagues, share ideas and try to help each other. But, due to the prevention of the spread of Coronavirus, the teacher only explains (lectures), and students follow (listen). (Interview: 12th March, 2021).

Hence, it was reported that students' results in upcoming national exams would drop due to COVID-19 since students did not adequately revise their lessons while they were at home. Also, students seem to be not concentrated even when they are back to school. To deepen this, we asked participants in the study how they think the outspread and effects of COVID-19 will affect Grade 12 student's performance in mathematics and sciences for the upcoming national examination of July 2021. The DOS at School 1 confirmed: *"Of course. There are effects. Students think of other occupations they were in before resuming their studies and are not currently performing well. We are worried that they can fail national exams or get fewer marks compared to what they were supposed to get" (Interview: 11th March, 2021).*

In the same vein, the DOS at School 2 replied:

Thank you. COVID-19 will affect students' performance. Even if we did revisions, but students have forgotten a big part of the content. It seems we need to restart again. Moreover, sciences and mathematics require students to learn

these subjects with concentration and repetition consistently. This means that there are impacts on national exams, although we are looking to overcome those challenges (Interview: 11th March, 2021).

To mitigate the effects of COVID-19 and boost students' performance of Grade 12 students, strategies are being employed, such as guiding and counseling students, preparing many assessments, and using extra time, including using weekends to teach them.

Asked the envisioned teaching strategies or other mechanisms they plan to mitigate the negative effects of COVID-19, to help Grade 12 students to improve their performances of mathematics and sciences, a Mathematics teacher at School 1 answered:

We have changed the way we assess students. Because we already know that students are bored (tired), that the teaching and learning become long, and that the levels of students have reduced. Therefore, it required us to prepare them seriously and assess them several times compared to how often we used to do. This means to occupy them and make them busy, with many exercises for revision since the Ministry of Education also gave us almost two weeks for revision... (Interview: 11th March, 2021).

Besides, the DOS at School 2 reported complementing in these words:

Thank you. Different measures have been taken, such as having remedial exams and catch-ups as prepared by Rwanda Education Board (REB). For students in Grade 12, teachers use the extra time to teach them, like 50 minutes or an hour per day. Some teachers also plan with students to come very early in the morning before the formal starting time of the lesson and teach them. Some teachers use even the weekends like on Saturdays... We also have regular assessments we prepare for students.

Those are the measures we took to help students improve their performance (Interview: 11th March, 2021).

The results got from teachers, triangulate with the results collected from students. The results found from the survey questionnaire showed that the majority of students (56%) did not use remote learning. Students who did not use remote learning agreed that they did not have learning facilities such as television (58%), a computer (81%), and a smartphone (73%). Others agreed that they were busy with other household activities like looking for food, cooking, and looking after livestock (48%). However, those students (44%) who used remote learning, agreed that they followed the content prepared and diffused on radio and television. Students also reported that they used connected computer and/or smartphones to read online reading materials.

The majority of students (84%) reported that their schools did not facilitate them in their learning of mathematics and science during the lockdown period. A significant number of students (58%) agreed that not all students come back to school after their studies are resumed. Some of the reasons reported by students are that some students went to look for jobs, agreed by 67% students, some young girls got pregnant and chose to stay home, agreed by 77% of students, while others married illegally, as agreed by 65% students. However, lack of school fees and learning materials were some of the barriers reported by students that prevented students to come back to school, when studies were resumed.

While talking about the learning and school environment in respect to COVID-19 prevention, 46% and 53% of students disagreed that they learn effectively even if they do not have entertainment and sports respectively. However, 15% and 18% of students remained neutral to these statements respectively. Forty-three percent of students (43%) disagreed that it is challenging to keep

1-meter social distancing. However, 15% of students remained neutral to this statement. Thirty-five percent of students (35%) disagreed that they effectively learn through the lecture teaching method, while the majority of students (74%) agreed that they need to learn through group discussions.

Discussion

This study showed that there are various negative effects of COVID-19 on Grade 12 students' school attendance and performance, especially in sciences and mathematics. The negative effects of the COVID-19 pandemic did not only affect Grade 12 students but also reached other children of schooling age in general. The major problem caused by this pandemic is that students have dropped out after spending a long time at home (Oyinloye, 2020). Some adolescent girls were involved in uncontrolled sexual exploitations, whereby some of them consequently got pregnant, while others were engaged in early marriages (Rwigema, 2021; Save the Children, 2020). Other students dropped out because they are indifferent jobs (See Rwigema, 2021), while others started their businesses to survive. School drop-out is a big challenge in developing countries since students who dropped fail to maximize their potentials. For instance, early marriage results in giving birth to many children with minimal abilities to feed them by their parents (Sabates et al., 2011; Save the Children, 2020; Tadesse & Muluye, 2020).

The remote learning that was supposed to keep students learning at home was not effectively exploited since students were busy with other household chores. This has caused inequalities in access to education since children whose parents' background is low are likely to get very little motivational and monitoring support from their parents (Pietro et al., 2020; Rwigema, 2021; Sabates et al., 2011; Save the Children, 2020). Also, children from low-

income families cannot get technological tools that can be used in remote learning, like computers, internet connectivity, television, and radio (Putra et al., 2020; Tadesse & Muluye, 2020). This has resulted in a drop in students' level of performance (Oyinloye, 2020), whereby mathematics and sciences are mostly affected. Moreover, these subjects require students to spend sufficient hours interacting with teachers. Also, mathematics and science subjects are effectively acquired when students consistently revise the content to understand the scientific and mathematical concepts deeply.

The study results revealed that the learning conditions at school are not conducive, which results in students feeling demotivated and not concentrated on their studies. For instance, students are worried that at any time, they can go back into lockdown. Sports activities, entertainment, and external visits by parents have stopped. However, all these activities help science and mathematics students learn effectively and help other students in general since they benefit from them in relaxing and refreshing their minds. Students are not easily collaborating at school through group discussions due to social distancing to prevent the spread of the pandemic. This also affects students' performance since they can share ideas and help each other through these groups. In other words, students' social life was also affected (Save the Children, 2020).

Although negative effects are apparent, different measures have been taken to mitigate them. That is why school authorities opted to talk to students and offer advice to motivate them to learn. It is also noticed that the school authorities and teachers are working hard to boost students' performance (Kuhfeld et al., 2020; Putra et al., 2020). The evidence is that some teachers are using extra hours and even use weekends to prepare Grade 12 students for the upcoming national examinations of July 2021 and regular and several assessments of students' learning. Although these measures

are in place, those who prepare for national exams such as REB are called to consider all the challenges brought about by COVID-19 since students were academically, psychologically, socially, and economically affected (Akat & Karataş, 2020; Sintema, 2020).

Even if some DOSs and teachers hope that the learning conditions will come to a normal situation after the COVID-19 pandemic, all the effects will not end at once. The educational planners at the national level and educationists at the school level will need to keep on dealing with COVID-19 post effects by providing sufficient learning support to students until everything is stable, whereby students will be feeling comfortable, ready, and happy to learn (Kuhfeld et al., 2020; Rwigema, 2021).

Conclusion and implication for further studies

It has been shown that the COVID-19 pandemic has negatively affected all students' lives in general and Grade 12 students, in particular, the students who are preparing for the forthcoming national examinations. COVID-19 negatively affected students' school attendance, academic performance, social and psychological life. Although the vaccines of COVID-19 are being given to the citizens in Rwanda, students included, however, the contaminations are still apparent. While dealing with the COVID-19 pandemic in schools, there is a hope that the Ministry of Education will continue intervening by providing the required educational services that facilitate learning, considering that the pandemic challenges are still there. Similarly, there is a hope that all the measures that educationists in Rwanda will further take will be benefitting students to learn and perform effectively towards lifelong learning of Rwandan citizens.

The results of this study open door to further researches. Therefore, similar studies can be

conducted countrywide investigating the relationship between COVID-19 psychological and social effects and students' performance in mathematics and sciences. Another research can also be undertaken looking into the impact of teaching strategies during the COVID-19 pandemic on students' performance in sciences and mathematics.

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