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Abstract

The global learning crisis has, rightfully, taken center stage over the past few years, with an increasing focus on supporting policies aimed at improving learning outcomes. However, the COVID-19[1] pandemic has led to extended school closures worldwide, forcing over 1.8 billion children out of school, and in many cases, with limited access to effective remote learning. School closures in Sudan have led to concerns about the potential long-term learning losses this may entail for several generations of children. For Sudan, the challenge is formidable. The country has undergone a popular revolution to overthrow a 30-year old dictatorship amid worsening macroeconomic conditions. Taking over in September 2019, the Transitional Government introduced an ambitious education reform agenda, with policies that, if fully implemented as intended, may have a significant impact on improving learning outcomes for all. This paper simulates the potential impact of both COVID-19 related school closures as well as the intended policy reforms on learning outcomes and equity. We simulate the effects of these shocks under different assumptions, including the likely duration of school closures, and effectiveness of remote learning solutions adopted by the Government, as well as education financing levels and the capacity of the Government to fully implement the policy reforms. Given equity concerns around the potential COVID-19 impact, we also consider the effects on children from households within different wealth quintiles. The findings show that school closures may have devastating impacts on learning outcomes, especially for children from poorer families. However, the simulations also indicate that the policy focus of the education reform agenda, as well as the stated commitment to increase education financing, have the potential to mitigate short-term learning losses due to COVID-19 and significantly improve learning over time. The findings suggest that increasing education budgets and implementing key reforms will be critical to rebound from the effects of COVID-19 in the short- to medium-term.

Keywords: Learning Outcomes, Education Financing, Education Policy, COVID-19 impact, Sudan.

JEL Classifications: I21, I22, I28, H52, H68.

ملخص

لقد احتلت أزمة التعليم العالمية، بحق، مركز الصدارة خلال السنوات القليلة الماضية، مع زيادة التركيز على السياسات الداعمة التي تهدف إلى تحسين نتائج التعلم. ومع ذلك، أدت جائحة كورونا كوفيد 19 إلى إطالة إغلاق المدارس في جميع أنحاء العالم، مما أجبر أكثر من 1.8 مليار طفل على عدم الذهاب إلى المدارس، وفي حالات كثيرة كان ذلك مصحوباً بمحدودية الوصول إلى التعلم الفعال عن بعد. أدى إغلاق المدارس في السودان إلى مخاوف بشأن تأثير خسائر التعلم المحتملة التى قد تستمر لأجل طويل نتيجة لهذا الإغلاق على عدة أجيال من الأطفال. بالنسبة للسودان، فإن التحدي هائل. شهدت البلاد ثورة شعبية للإطاحة بدكتاتورية عمرها 30 عامًا وسط تدهور ظروف الاقتصاد الكلي. بعد تولي الحكومة

[1] COVID-19 – Coronavirus Disease 2019

الانتقالية زمام الأمور في سبتمبر 2019، قدمت أجندة طموحة لإصلاح التعليم، مع سياسات، إذا تم تنفيذها بالكامل على النحو المنشود، فقد يكون لها تأثير كبير على تحسين مخرجات التعلم للجميع. تحاكي هذه الورقة الأثر المحتمل لإغلاق المدارس نتيجة لجائحة فيروس كورونا كوفيد 19 وكذلك أثر إصلاحات السياسات على نتائج التعلم والمساواة. ونقوم هنا بمحاكاة آثار هذه الصدمات في ظل افتراضات مختلفة، بما في ذلك المدة المحتملة لإغلاق المدارس، وفعالية حلول التعلم عن بعد التي اعتمدتها الحكومة، وكذلك مستويات تمويل التعليم وقدرة الحكومة على التنفيذ الكامل لإصلاحات السياسات. نظرًا للمخاوف المتعلقة بالمساواة بشأن التأثير المحتمل لفيروس كورونا كوفيد 19، فإننا نأخذ في الاعتبار أيضًا التأثيرات على الأطفال الذين من أسر معيشية ذات مستويات ثروة مختلفة. تظهر النتائج أن إغلاق المدارس ربما يكون له آثار مدمرة على نتائج التعلم، وخصوصاً بالنسبة للأطفال من الأسر الفقيرة. ومع ذلك، تشير عمليات المحاكاة أيضًا إلى أن التركيز السياسي لأجندة إصلاح التعليم، فضلاً عن الالتزام المعلن بزيادة تمويل التعليم، لديه القدرة على التخفيف من خسائر التعلم قصيرة الأجل بسبب جائحة فيروس كورونا كوفيد 19 وتحسين التعلم بشكل كبير بمرور الوقت. تشير النتائج إلى أن زيادة ميزانيات التعليم وتنفيذ الإصلاحات الرئيسية سيكون أمرًا بالغ الأهمية للانتعاش من آثار جائحة فيروس كورونا كوفيد 19 على المدى القصير إلى المتوسط.

1. Introduction

Many children spend years in school without achieving adequate foundational skills, particularly early literacy skills, which are necessary to successfully advance through and complete their education. This has been flagged in recent years as a global "learning crisis"[2], one which is likely to be further exacerbated by the impact of the global COVID-19 pandemic. For Sudan, the learning crisis was already a critical issue even prior to COVID-19, with an estimated 40 percent of 10-year-olds not able to read and understand a simple text[3]. Since the detection of the first cases in Sudan in mid-March 2020, and due to risks of community spread, schools have closed[4], leaving approximately 7.3 million basic and secondary education learners[5] out of school. Tertiary education institutions also experienced several rounds of closures and re-openings balancing between on-campus and online learning. Schools have reopened in February 2021 after nearly 8 months, but there are still risks that they may close once more if COVID-19 cases spike again. This prolonged period of school closure raises concerns about the depth of the learning loss, the challenges students will face upon re-entry, and the long-term ramifications this may have on multiple generations of students.

The pandemic has also become a threat to the fragile transition process in Sudan, adding to the already precarious socio-economic conditions inherited by the recently formed Transitional Government. The latter took office in September 2019, in the aftermath of a popular revolution which toppled the 30-year old regime of former President Omar al Bashir. The new Government committed, early on, to pursue a human capital-driven approach to economic development, outlining an ambitious education reform program with the objective of improving access to quality education for all Sudanese children. The proposed scope of the program is broad, and the reforms target critical areas aimed at improving learning outcomes, including curriculum reform, provision of adequate teaching and learning materials, support to teachers, and a commitment to increase education budget allocations, among others.

In this paper, we examine the potential impact of the ambitious education reform agenda on learning outcomes, but also the potential learning loss from the extended period of school closures. The paper contributes to the literature by simulating the impact of these twin shocks on learning outcomes and education financing and provides empirically grounded support for preserving public spending on social sectors during times of crisis.

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[2] Saavedra J. et. al. (2020)

[3] World Bank Human Capital Index 2018

[4] The government tried to re-open schools several times but has not been able to due to numerous challenges including major floods that impacted millions of people and destroyed hundreds of schools over the summer of 2020 and a second wave of the pandemic which struck in November 2020. School have reopened in February 2021, but it is unclear if this is permanent or if it may still be subject to change as the pandemic situation evolves.

[5] Government of Sudan, Sudan Annual School Census, 2019.

The paper is structured as follows: section 2 provides the context; section 3 describes the methodological approach and the data used in the analyses. Section 4 presents the results of the simulations. Section 5 looks at different policy assumptions and their impact on results. Section 6 concludes with a summary of the main findings.

2. Context

The impact of disruptions to schooling on learning outcomes is well documented in the literature. Andrabi et al. (2020) looked at the impact of school closures on learning outcomes following the 2015 earthquake in Pakistan and found that although there was no impact on enrollment or drop-outs, children who stayed out of school longer, those who were closer to the epicenter, had lower learning levels – an additional month out of school was associated with a further decline in scores of 0.016 SD or 10 percent of a (ten-month) school year. Similarly, Thamtanajit (2020) reported a 0.03 to 0.11 standard deviation decline, depending on grade and subject, when comparing results from students affected and not affected by the 2011 flooding in Thailand. Meyers and Thomasson (2017) look at the long-run impact of school closures on education attainment during the 1916 polio pandemic. They conclude that a one-standard-deviation increase in the number of polio cases reported in a person's birth state resulted in the person having around 0.07 fewer years of schooling, suggesting long term effects beyond the school closure period. Some studies, such as Bandiera et al. (2019), highlight the disproportionate impact on adolescent girls and children from vulnerable groups.

The World Bank also published a note on the likely impact of COVID-19 on education financing (World Bank, 2020). The findings suggest that while the economic fallout from the global pandemic is still unfolding, it is likely to result in a worsening of macroeconomic conditions, tightening of fiscal space, and possibly a reduction in education financing. Drawing from past examples, the note highlights that in times of crisis, many countries chose to cut education spending to make space for other priority areas[6]. Early indications point to similar trends once again. While there is limited evidence on the linkage between education spending and learning outcomes[7], it is evident that a decrease in education spending or even a reduction in the planned increase will likely limit the ability to implement the broad set of reforms aimed at improving learning outcomes.

[6] The public expenditure review for Zambia (World Bank, 2015) revealed that public spending on education decreased from 20.5 to 17 percent of total public education following the 2009 financial crisis. Similarly, during the Ebola epidemic in Sierra Leone, public education spending fell from 15 to 12 percent of total government spending between 2014 and 2017.

[7] Some examples linking declining public spending per capita to lower learning outcomes from Malawi and Madagascar are provided in Al Samarrai et al., 2019

The impact on education financing is of particular importance in Sudan's case, given that the education sector was already grossly underfinanced for the last decade[8]. The education budget as a proportion of the overall budget stood at 9 percent in 2018, much lower than the recommended 15-20 percent[9]. As a share of GDP, spending in education was halved from 2.4 percent in 2009 to 1.1 percent in 2018[10], which is the lowest in Sub-Saharan Africa. The new Transitional Government made a commitment to gradually increase the share allocated to the education sector up to 20 percent by 2022. In 2021, the education sector is expected to receive 12.5 percent of the national budget.

The impact on education financing will likely depend on the evolution of the macroeconomic situation. The latter was already precarious prior to the pandemic, but the situation has deteriorated further, with the inflation rate reaching a record 166.8 percent[11] in August 2020. The official US dollar exchange rate is about SDG55/US$1, while the parallel black-market rate has reached SDG400/US$1, fueling shortages of critical commodities and contributing to the inflationary pressures. However, there may be some economic relief on the horizon. In December 2020, the US removed Sudan from the state sponsor of terrorism list, which is expected to help the country access much-needed debt relief, multilateral lending, and investment. Given the structural reforms already taking place, the IMF is forecasting that the GDP growth rate will rebound to 0.8 percent for 2021, from an expected contraction of -8.4 percent in 2020. The situation in the country is evolving quickly, and the findings of this paper may be updated in the future based on new available data.

3. Methodology and data

3.1. Methodological framework

The impact of the twin shocks on learning outcomes – the introduction of a set of policy reforms in the education sector and the COVID-19 pandemic – are estimated using two models. The first is a calibrated Pedagogical Production Function (PPF) developed by Kaffenberger and Pritchett (2020)[12], which is used to simulate the impact of policy reforms on learning. The second is a simulation model developed by the World Bank (Azevedo, Hasan, Goldemberg, Iqbal, and Geven, 2020)[13] and is used to estimate the impact of the COVID-19 pandemic on learning outcomes. The net effect of the twin shocks on the learning outcomes is then simulated under different assumptions regarding the effectiveness of mitigation measures adopted during school closures to

[8] Public spending on education as a share of total public expenditure was also low prior to secession of South Sudan in 2011, ranging between 7 and 12 percent

[9] Based on international benchmark. See full Incheon Declaration at http://en.unesco.org/world-education-forum-2015/incheon-declaration

[10] Sudan Education Sector Analysis 2018. Ministry of Education of the Republic of Sudan.

[11] Central Bureau of Statistics of Sudan

[12] https://riseprogramme.org/sites/default/files/publications/RISE_WP-038_Kaffenberger_Pritchett_1.pdf

[13] http://pubdocs.worldbank.org/en/798061592482682799/covid-and-education-June17-r6.pdf

reduce learning losses, such as the use of radio and TV programs as mediums for remote learning. Short- to medium-term impacts on education sector financing and learning outcomes is also simulated under different policy assumptions, including: (i) the degree to which the Government will implement its education policy reform program – here two scenarios are considered: fully implemented or 50 percent implementation; and (ii) the level of commitment to increasing education financing as a share of the total budget – here three cases are explored: 12.5 percent, 15 percent and 20 percent. Below is a brief description of the two models (the annex presents the models in more detail).

Modeling the impact of policy reforms on learning outcomes

The first step, as described in Kaffenberger and Pritchett (2020), is to develop a parameterized specification of the learning process by identifying the key factors which drive learning using a Pedagogical Production Function (PPF). The calibrated parameterized learning process is then used to simulate the impact of shocks, such as policy scenarios, on learning outcomes. The impact is measured by altering the parameters of the calibrated PPF model to estimate the impact of different policy reforms on learning outcomes.

Kaffenberger and Pritchett (2020) describe the PPF as modeling the learning gained by children at different points in a student distribution in a year of schooling- i.e., on average, what child *i* with skill level *s* would learn if they attended grade *G*. They represent this process as follows:

$$Learning\ process\ (LP) = LP^{G}\left(s^{i}\right) \tag{1}$$

The authors also assume a trapezoidal functional form for the PPF, defined in the equation below[14]:

$$PPF\left(LP(w,h,r,\pi^{G}),s^{i}\right) = \begin{cases} h_{min} + r\left(s^{i} - \left(\pi^{G} - \frac{w}{2}\right)\right) if\ \frac{\pi^{G} - \frac{w}{2} < s^{i} < \pi^{G} + \frac{w}{2}}{} \\ 0\ if\ s^{i} < \pi^{G} - \frac{w}{2} \\ 0\ if\ \ s^{i} > \pi^{G} + \frac{w}{2} \end{cases} \tag{2}$$

where the learning in grade *G* of student *i* of initial skill *s* is a function of the width *w*, height *h*, slope *r*, and center $\pi^{G}$of the trapezoid. $h_{min}$is the amount learned by the child with the lowest

[14] A detailed description of the formula is found in the Kaffenberger and Pritchett (2020).

initial skill level that learns anything at all, and $h_{max}$is the amount learned by the child with the highest initial skill level that learns anything; r is defined as:

$$r = \frac{rise}{run} = \frac{h_{max} - h_{min}}{w} \quad (3)$$

π^1 is the student skill level that is the center of the PPF for grade 1. Parameter, *p*, "pace", is the magnitude of the shift in the PPF from grade *G* to grade *G+1* or *G-1,* and *x* is the maximum grade.

$$\pi^G = \pi^1 + (G-1) * p, \forall G = 1, \dots x) \quad (4)$$

To customize the PPF model to the data available for Sudan, the following three steps are taken: (i) the first step is to estimate the learning outcome indicator, the Harmonized Learning Outcome (HLO) score, based on a methodology developed by Altinok, Angrist, and Patrinos (2018) which allows for the construction of standardized and comparable learning outcome indicators using national or regional learning assessments[15]. Using this methodology, we convert country assessment data to an international scale, such as PISA-D (see annex A for details). For Sudan, we use the Grade 3 2017/18 National Learning Assessment (NLA) to calculate the HLO; (ii) the second step in setting up the PPF consisted in estimating the parameters used to calibrate our model. Here, we run a least-squares regression to identify determinants of learning. The specification of the model is based on well-documented research on factors that impact learning—teachers, learners, school management, and school inputs. The limitations of the data are discussed later in the paper.

In order to estimate the determinants of learning, we identify indicators which serve as proxies for the four main areas which the literature, including the flagship 2018 World Development Report, indicates are key determinants of learning: teachers, learners, school management, and school inputs. Teachers who are skilled and motivated are critical to the provision of quality education and are likely to be the most influential factor on learning outcomes. Based on available data, we use the share of teachers in the school having the minimum qualifications as a proxy for the qualifications of the grade 3 teacher, with the assumption that better-qualified teachers translate to better-skilled and motivated teachers. We include the average class size as a proxy for the teaching conditions, given that large class sizes tend to be more difficult to manage and teach. Students who attend pre-primary school tend to be better prepared to learn in grade school, impacting their learning outcomes in later grades. We use the share of students enrolled in grade 1 who have attended pre-school as a proxy for the learner readiness in the regression analysis.

[15] Altinok, Nadir, Noam Angrist, Harry Anthony Patrinos. "Global Data Set on Education Quality (1965–2015)". World Bank Policy Research Working Paper, no. 8314 (2018)

In addition, we estimate the average years of schooling within the school. The rationale is that a school where more students survive to the last grade, and therefore have higher average years of schooling, may suggest that the student is evolving in a community which prioritizes education. School management can also have an impact through the support provided to teachers and students. Although the data does not capture specific indicators to that effect, it does capture Parent-Teacher Association contribution to the school, which we use as a proxy for resources available to the school administration to improve the learning conditions and support teaching through in-service teacher training. We also consider the share of volunteer teachers at the school level as a proxy for parent/household allocation of resources to the school. Lastly, the availability of school inputs such as teaching and learning materials, as well as key infrastructure, is expected to improve the learning environment and strengthen the teacher-student interaction. We consider several indicators, including the availability of textbooks, latrines, electricity, water. We also capture the share of grades that do not have physical classrooms. In those cases, classes are held outside, in open-air classrooms. The data is used to calculate the school-level Socio-Economic Status (SES).

We also run a multinomial logit regression to estimate the relative gap in learning gains for students with low and high initial learning skills[16]. The estimates of the coefficients are used to calibrate the PPF model and used to simulate how government reforms affect students with different learning skills (see Annex B); and (iii) the last step consisted in identifying the core policy reforms, and their associated estimated impact on learning outcomes. The estimated impact of each policy reform is drawn from the literature, in particular, drawing on a Survey of Expert Opinion conducted on 40 Education Interventions in Latin American countries and six countries in Sub-Saharan Africa[17]. The details of each policy reform in Sudan and the corresponding impact on learning outcomes are presented in Annex C.

Modeling the impact of COVID-19 on learning outcomes

To estimate the impact of COVID-19 on learning outcomes, we use a simulation model developed by the World Bank[18] , which posits that the learning losses due to the COVID-19 related school closures, measured by the change in the learning score (in the HLO scale), is a function of three

[16] Initial learning skills are calculated based on the HLO distribution within quintile of socioeconomic status (SES) of the schools, i.e. children attending school in the bottom 10 percent of the HLO in each SES quintile are mapped to low skills while children in the top 10 percent of HLO score is mapped to high skills in each SES quintile.

[17] Ernesto Schiefelbein, Laurence Wolff, and Paulina Schiefelbein (1988), Cost-Effectiveness of Education Policies in Latin America: A Survey of Expert Opinion, and Cost-Effectiveness of Primary School Interventions in English Speaking East and West Africa:A Survey of Opinion by Education Planners and Economists (2007): By Ernesto Schiefelbein and Laurence Wolff

[18] Joao Pedro Azevedo, Koen Geven, Diana Goldemberg, Amer Hasan, Syedah Aroob Iqbal (2020) "Country tool for simulating the potential impacts of COVID-19 school closures on schooling and learning outcomes, Version 5". World Bank, Washington DC. http://pubdocs.worldbank.org/en/798061592482682799/covid-and-education-June17-r6.pdf

factors: (i) the duration of the school closure; (ii) the measures taken to mitigate learning loss and their effectiveness, and (iii) the learning gains expected in one year (school productivity[19]). The adapted model is represented as follows:

$$\Delta\ HLO = f(s,\ m_w,\ p)$$

where,

s, school closure (as a share of the school year—a typical school year is 10 months)

w, welfare quintile proxied by Social Economic Status (SES)

$\boldsymbol{m_w}$, mitigation effectiveness, by welfare quintile (w)

p, learning gains (school productivity)[20]

The simulation model assumes different degrees of severity of impact on the learning outcomes based on the duration of the school closures (s) and the effectiveness of the mitigation effects in place. In our adaptation of the model, we define three scenarios: the low impact scenario where schools are closed for 8 months, an intermediate scenario that assumes 10 months of school closure, and a high impact scenario where schools would be closed for 12 months.

The model also accounts for the effectiveness of the strategies to mitigate learning loss (m), for example, the use of remote learning solutions during school closures such as radio and TV programs. The model assumes that remote learning is never as effective as classroom instruction and brings together three elements, the government supply (or expected coverage) of alternative education modalities (G), the ability of households to access these alternative modalities/actual government supply of distance learning (A), and the effectiveness of this alternative modalities (E). Hence, mitigation effectiveness of alternative modalities (m) = G * A * E.

The expected school productivity (p), or how much students are expected to learn as they move from one grade to the next, is based on the literature on school productivity, unexpected school closures, and summer learning loss. Based on the literature, the model assumes that learning gains will vary from 20 to 50 learning points[21] depending on the country's income level. For Sudan, as a low-income country, school productivity is assumed to be equivalent to 30 learning points.

[19] The model assumes that learning gains will vary from 20 to 50 learning points depending on the country's income level, which is equivalent to 0.2 to 0.5 of a standard deviation. These assumptions is in line with the literature. More details on the model and the underlying assumptions are found in World Bank (2020a).

[20] For simplicity, the basic simulation assumes that, within a country, children have the same school productivity regardless of socio-economic status.

[21] See World Bank (2020a) for more detailed explanation on the research evidence which underpins this assumption, including the references to the vast literature documenting the heterogeneity of schooling productivity.

3.2 Data

In order to simulate the impact of both the policy reforms and COVID-19 on learning outcomes in Sudan, we rely on several key data sources. The key learning outcome indicator, the HLO, is calculated using the most recent National Learning Assessment (NLA), which was carried out in 2017/18. The NLA is a sample-based student assessment of reading and mathematical proficiencies representative at the national level and for all 18 states of Sudan. The NLA is adapted from the Early Grade Reading Assessment (EGRA) and Early Grade Mathematics Assessment (EGMA). The 2018 assessments were carried out for both Grade 3 and Grade 6 students. However, for the purpose of this study, we focus on learning outcomes for Grade 3 in reading. In 2018, 15,252 Grade 3 students from 741 schools across 18 states participated in the NLA.

The NLA did not provide much contextual data on the school or student's background characteristics. In order to estimate the determinants of learning, we link the learning assessment data with contextual data from the Sudan Education Management Information System (EMIS).

The EMIS captures school census survey data and is carried out every year since 2013/14 by the Planning Directorate of the Ministry of Education of Sudan in all basic (primary) schools. The EMIS collects the key school-level information, such as student enrollment, staffing, and infrastructure facilities. In the regression analysis, we use the 2017/18 data, which covered all 19,379 basic schools.

To simulate the potential effect of policy reforms, the analysis also relied on qualitative information from the 2020 National Education Conference paper outlining the proposed reform agenda. The major reforms are categorized across five areas: (i) education system; (ii) teacher issues; (iii) curriculum; (iv) school environment; (v) pre-school and (vi) education financing. Such comprehensive reforms may take a long time to be implemented, usually, anywhere between three to five years. For the purpose of our simulation, we assume that it will take Sudan four years to fully implement the policy reforms. As such, students taking the Grade 3 assessment in four years, would also be the first cohort of children to benefit from the full implementation of reforms, having completed preschool and the first three grades of primary education in that period. The corresponding impact factor of each policy reform area, as mentioned earlier, is taken from the meta-study on the Survey of Expert Opinion conducted on 40 Education Interventions in Latin American countries and six countries in Sub-Saharan Africa. The reforms and the associated impacts are detailed in the annex (Annex C, Table C1).

We use the 2014 Multiple Indicator Cluster Survey (MICS) to calculate the share of households with access to the internet, computers, mobile phones, landlines, radio, and television by wealth quintile. These are used as input in the model to determine the effectiveness of mitigation measures. The decomposition of access to remote learning modalities by wealth quintile is a key

component of the model as it aims to capture the disparities in the impact on learning outcomes across vulnerable groups. We also used data from the Multitopic High-Frequency Survey (HFS), a nationally representative survey administered by the World Bank, to monitor the impact of COVID-19 on Sudanese Households. Round 1 was conducted from June 16-July 5, 2020. Qualitative information was collected on the school closures and the mitigation measures adopted by the Government, such as supply of alternative learning modalities (e-learning and other distance learning options).

Lastly, to simulate the impact of COVID-19 on education financing under different scenarios, we rely on the IMF macroeconomic data and projections of such indicators as nominal GDP, GDP deflator, and total public expenditure. The data is drawn from both the 2019 Article IV publication released in March 2020, which included pre-COVID-19 projections, as well as the follow-up Staff report from October 2020, which captured the post-COVID-19 impacts. The simulation also draws on the education budget spending data captured in a recently prepared World Bank policy note on Education Financing in Sudan (2020).

3.3 Assumptions and limitations

Before presenting the results of the simulation models, it is worth outlining the limitations of the analysis. First, the worsening of Sudan's economic situation will also likely impact household incomes, but this effect on learning outcomes is not captured in the simulation models. As demonstrated in the literature, household income shocks often impact household decisions on schooling. In particular, it may lead to children spending less time in school or altogether withdrawing from school, shifting time use to supporting economic activities for the household instead. It may also imply fewer resources will be provided to the child. In Sudan, households contribute on average about 65 percent of total education spending, from spending on uniforms, learning materials, contribution to school PTA, and transportation. The reduction in household education spending per child may affect the child's learning conditions. In this respect, the simulations may be underestimating the potential decline in learning outcomes.

Second, the analysis of learning determinants, which serves as input into the PPF model, is limited by the availability of student-level data in the NLA. The latter does not include modules to capture student, teacher, or school background information. As noted earlier, the contextual indicators are constructed by linking the learning assessment data to school-level information using the EMIS. Having the contextual data from the NLA would have enabled us to measure the learning losses more accurately.

Third, the policy reforms used in the PPF model are, in effect, capturing the intent of the Government rather than the actual policy implemented. It is difficult to assess, at this stage of the mandate, how realistic and likely it is that the full policy agenda will be implemented.

Fourth, the effectiveness of the policy reforms, and therefore the likelihood of seeing the expected impact, depends on the degree of implementation fidelity-that is the degree to which the implementation follows the intended design. Disparities between the intended policy reform and the actual implementation on the ground are often why some interventions are deemed not effective when in fact, it is a reflection of the quality of the implementation of the intervention. The simulations do not make provisions for this and may overestimate the impact of the policy reforms.

Fifth, the model relies on estimates from regional and meta-studies to estimate the potential impact of the policy reforms on the learning outcomes in Sudan. There may be some concerns around the external validity of the results produced in these meta-studies and their applicability to the Sudanese context. This paper is also limited by the lack of local research on how various interventions impact learning outcomes.

4. Impact of the twin shocks on learning outcomes and education financing

4.1 Results from simulation of the impact of Government reforms on learning outcomes

Determinants of learning

The results from the regression analysis on the determinants of learning reveal that most of the indicators identified are statistically significant, and that jointly, the model specification is strong (F-stat for full model is 69). Ten of the eleven explanatory variables included in the regression, based on the drivers of learning identified in the methodological section earlier, are statistically significant in determining learning outcome (HLO)- most significant at the 1 percent and 5 percent levels. In particular, the results show that access to electricity, the share of qualified teachers, access to learning materials such as textbooks, as well as having attended pre-school have large coefficients and are highly statistically significant. For example, (i) having access to electricity at the school increases the mean scores by 24.6 HLO points, everything else held constant, (ii) a 1 percentage point increase in the share of qualified teachers, on average, increases the score by 15.4 points, (iii) an increase of 1 percentage point in the share of English or Arabic textbooks per child, increases scores, on average, by 16.3 points, and (iv) an increase of 1 percentage point in the share of children entering grade 1, having completed pre-school, would increase, on average, scores by 9.4 points. The summary statistics, as well as the description of the full results, are presented in the annex (Annex B, Table B1, and Table B2).

Simulation of the impact of policy reforms

Only those explanatory variables which are impacted by the policy reforms are used for the simulation exercise on the learning outcome indicator (HLO). The proposed reforms affect eight[22]

[22] Of the eight explanatory variables, access to water is not statistically significant which could be explained by that fact that 94 percent of basic education schools in Sudan have access to water.

of the eleven variables included in the model. Table 1 below presents the summary of results. The first column shows the average HLO at baseline as well as the baseline coefficients (marginal effect) of each explanatory variable, at the national level. The next columns show the simulation results, after taking into account the effect of the policy reforms, disaggregated by gender and student learning skills level. The simulation results are presented only for those variables which are impacted by the policy intervention areas and which are statistically significant (Annex Table B2 presents the baseline coefficients for the disaggregated average scores and coefficients by gender and learning skills levels). The simulation results show the expected impact on learning outcomes after the four years of implementation, if policies are fully implemented as intended.

The simulation results shown below, which do not yet reflect the effects of COVID-19, indicate that the policy prioritization by the Government, as proposed in the National Education Conference paper, are well aligned with intervention areas, which are expected to boost learning outcomes for all. The results show that, if implemented fully and as intended, the policy reform agenda proposed by the Government could boost average learning outcomes in Sudan from 380 to 466 at the national level (equivalent to an increase of 21.4 points in HLO scale annually for four years). Some of the policy areas which would boost learning levels the most are those aimed at improving teacher qualifications, improving school infrastructure and facilities to improve learning conditions, and expanding access to pre-school to ensure children are socio-emotionally and cognitively ready to learn when they enroll in grade school. The simulation also indicates that the average performance for boys would increase by 63 points of HLO, from 374 to 437, and by 106 points for girls, from 386 to 492. Similarly, the reforms increase learning outcomes for students with low initial learning skills by 68 points from 318 to 386 and by 93 points for students with high initial learning skills, from 503 to 596.

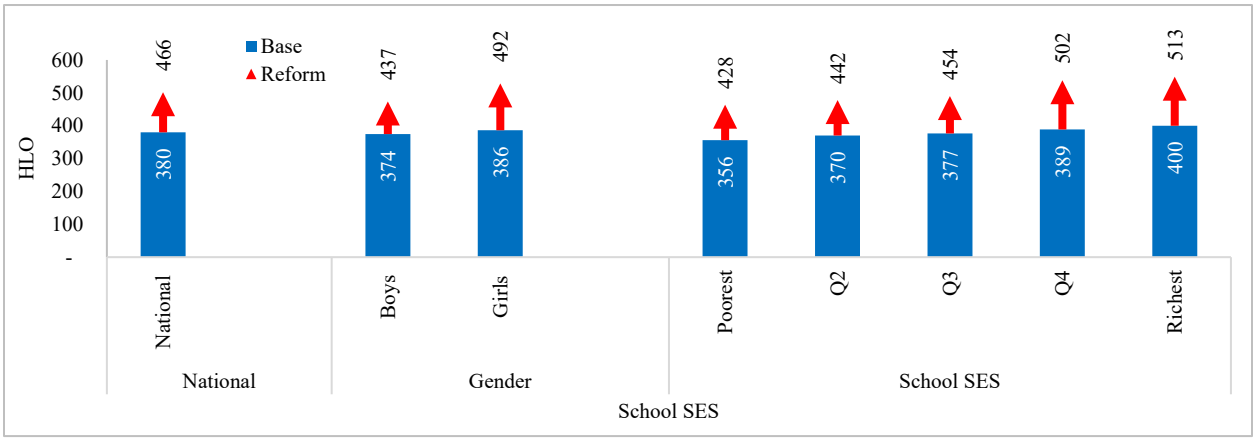
Table 1. Determinants of learning outcome and simulation of the impact of government policy reforms on learning outcome

Indicators	Baseline (national level)	Simulation results in points of HLO				
		National	Boys	Girls	Low skills students	High skills student
Average HLO	**380**	**466**	**437**	**492**	**386**	**596**
Explanatory variables (Coefficients/simulations)						
Student						
Average years of schooling	3.9	4.3	5.7	4.0	3.8	4.5
Share of children entry grade 1 with KG	9.7	11.1	14.5	6.4	9.1	11.8
Parent						
Log of HH school support	4.3	5.0	5.5	4.6	4.2	5.1
Ratio of volunteer teachers to teaching personnel	0.2	0.2	0.1	0.3	0.2	0.2
Teacher						
Share of teachers with degree	15.4	18.0	4.8	27.9	14.1	19.8
Pupil-teacher ratio	-0.05					
Learning materials						
English or Arabic textbook per child	16.3	18.8	7.1	28.4	15.1	20.5
School environment						
dummy=1 if school has electricity	24.6	28.2	24.9	34.2	21.1	31.7
dummy=1 if school has water supply	2.8					
Class size	-0.2					
Share of forms without a classroom	-0.1					

Source: Authors' estimation based on NLA, EMIS, government policy reforms
Note: baseline indicators for other categories, other than the national level, are presented in Annex B Table B2

We decompose the simulation by school-level SES (see Figure 1 below) and find that while students from all socio-economic backgrounds are expected to see improvements in learning, students attending schools with better-off SES are expected to benefit more from the reform program. This may reflect the lack of an explicit strategy targeting and focus on improving equity in the policy reforms, as outlined in the policy paper. Taking into account the initial learning skill differences, children from schools with the lowest quintile in terms of SES would increase their average scores by 72 points (20 percent increase), from 356 to 428, while children from the top quintile would increase their average scores by 113 points (28 percent increase), from 400 to 513.

Figure 1. Impact of planned reforms on learning outcomes (after 4 years), decomposed by gender and school SES



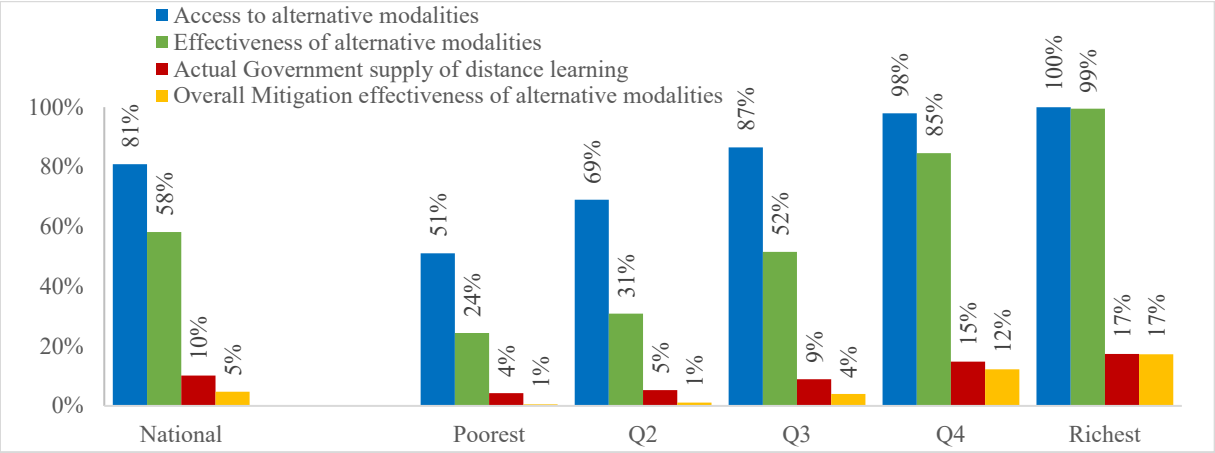
Source: Authors' estimation based on NLA (2017/18), EMIS (2017/18), government policy reforms
Note: Base year is 2020 and if the reforms implemented as planned in four years, learning outcomes are expected to increase to shown levels by 2024.

4.2 Impact of COVID on learning outcomes under three scenarios (without accounting for policy reforms)

Estimation of mitigation effectiveness parameter

The calculation of the mitigation parameter is estimated as m=G*A*E, where m is the overall mitigation effectiveness, G is the government supply (or expected coverage) of alternative education modalities, A is the level of access by households (actual government supply of distance learning) and E is the effectiveness of the alternative learning modalities. The calculation indicates that the overall mitigation effectiveness of the measures taken to support remote learning may, in fact, be very low- nationally estimated at 5 percent. The breakdown shows that 81 percent of households potentially have access to some form of remote learning modality—for example, TV or radio programs (see Figure 2 below). However, according to the Multitopic HFS survey, the effectiveness of these measures seems to be limited—only 10 percent of the families with school-age children were engaged in any learning/education activity since school closures went into effect. At the national level, given that the government supply (or expected coverage) of alternative education modalities is at 81 percent, the access by households of these alternative modalities/actual government supply of distance learning is at 10 percent, and the effectiveness of this alternative modalities is at 58 percent, the overall mitigation effectiveness is estimated to only 5 percent. We also note that the mitigation effectiveness of the remote learning solutions adopted by the Government varies for children from different wealth backgrounds. We decompose the mitigation effectiveness by wealth quintile and find that it ranges from 1 percent in the lowest quintile to 17 percent in the highest quintile (see Figure 2 below, which is based on the low impact scenario, assuming school closures of 8 months). The low mitigation effectiveness raises concerns about the long-term implications on learning as school closures are extended and the ability to mitigate those losses as time goes by.

Figure 2. Mitigation effectiveness parameter estimators, decomposed by wealth quintile



Source: Authors' estimation based on HFS (2020), EMIS (2017/18), and MICS 2014

Simulation of the impact of COVID-19

The simulation results, taking into account mitigation measures adopted by the Government to limit learning loss and their effectiveness, indicate potentially significant learning loss. Table 2 below summarizes the estimated learning loss average under the three possible case scenarios. Under the best of scenarios, "low impact scenario", where we assume 8 months of school closure (between March 2020-Jan 2021), therefore with 80 percent of the school year lost due to school closures, the average learning score is expected to decrease on average by 22.9 points, from 380 to 357. For the intermediate scenario, assuming school closure of 10 months (100 percent of the school year), the learning outcomes are expected to decrease by 29.1 points, from 380 to 331. In the worst-case scenario, where schools would remain closed for another two months (12 months in total), the overall average learning outcomes would be expected to decrease by 35.5 points, from 380 to 345, a significant setback for the education sector.

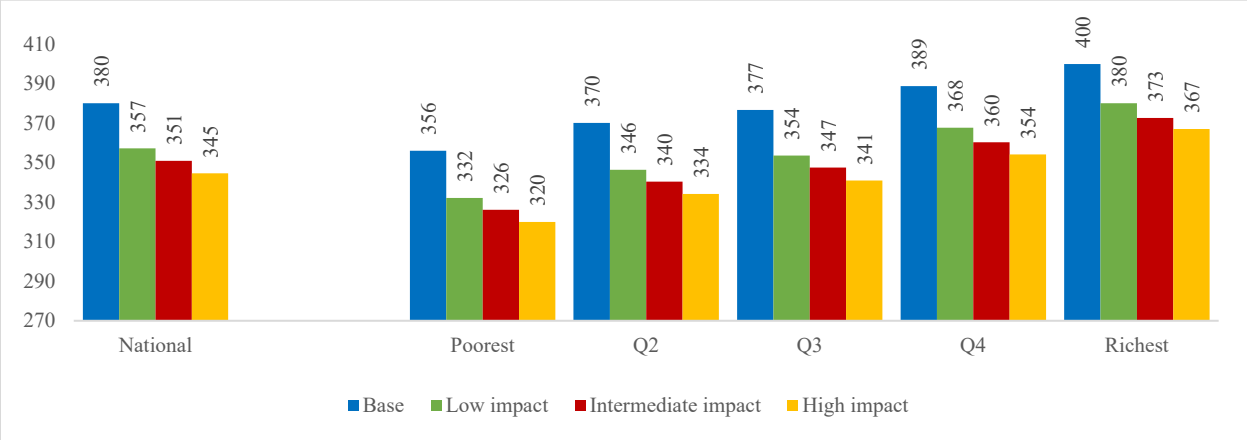
Table 2. Impact of COVID-19 on learning outcome under different scenarios

Parameters	Sudan
A. Learning gains or school productivity (in HLO points/year)	30
Optimistic Scenario	
B1. School closure (share of a school year)	80%
C1. Mitigation effectiveness (0 to 100%)	5%
D1. HLO decrease (points) = A*B1*(1-C1)	22.9
Intermediate Scenario	
B2. School closure (share of a school year)	100%
C2. Mitigation effectiveness (0 to 100%)	3%
D2. HLO decrease (points) = A*B2*(1-C2)	29.1
Pessimistic Scenario	
B3. School closure (share of a school year)	120%
C3. Mitigation effectiveness (0 to 100%)	2%
D3. HLO decrease (points) = A*B3*(1-C3)	35.5

Source: Authors' estimation based on NLA, EMIS, government policy reforms

The learning losses are likely to be felt differently for children from different socio-economic backgrounds. We estimate the learning loss for students across the wealth quintiles and find that the decline is expected to be higher among children from vulnerable backgrounds (see Figure 3). For example, under the low impact scenario, the average scores of children from the lowest wealth quintile are expected to decrease by 24 points, from 356 to 332, while those from the highest wealth quintile would see a decrease by 20 points, from 400 to 380. The learning losses are also high under the intermediate and high-impact scenarios.

Figure 3. Learning outcomes under different COVID-19 scenarios, decomposed by wealth quintile



Source: Authors' estimation based on HFS (2020), NLA (2017/18), EMIS (2017/18), and MICS 2014

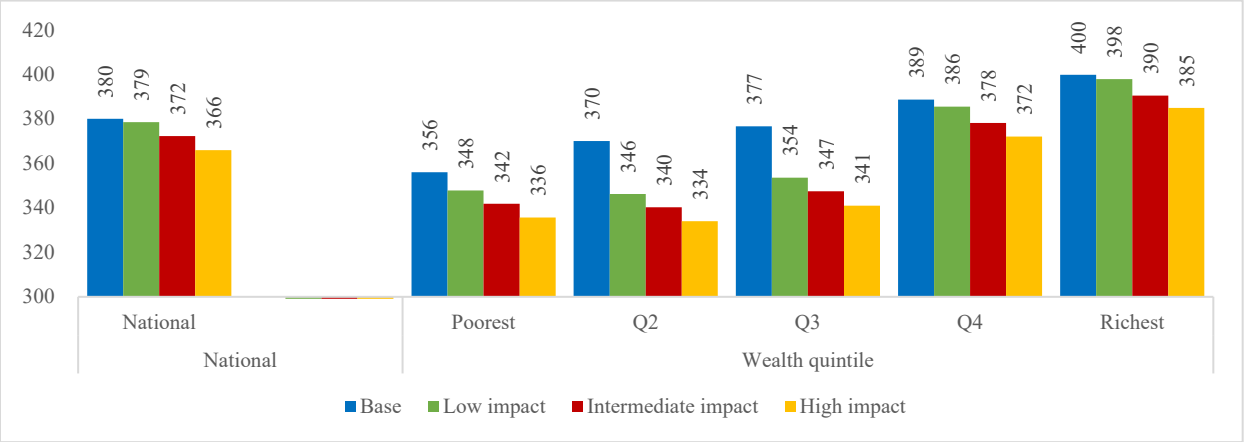
4.3 Results from simulation of the net impact of twin shocks

We present the expected net effect of the twin shocks on learning outcomes under the three COVID-19 scenarios (low-impact, intermediate, and high-impact) and under the assumption that

the Government is able to fully implement the policy reform agenda (see Figure 4 below). We also assume, under the intermediate and high-impact scenarios, that the Government is still improving on the mitigation effectiveness measures[23]. Lastly, in order to simplify the estimation of the combined impact, we assume that the increases in learning outcomes from the policy reforms are improving in equal increments over the 4 years.

The results show that if the government reform agenda is fully implemented, it may help to mitigate most of the learning losses due to COVID-19 in the short-term. Under the low-impact scenario, we could expect to see a net decrease in learning outcomes from 380 to 379 (positive impact from reforms of 21.4 HLO points, and a 22.9 decrease due to COVID-19, leading to a net decrease of 1.45). Under the intermediate scenario, the learning scores would decrease to 372, whereas under the high-impact scenario, the decrease would the largest, with a 14 point net decrease, at 366. The net impact is also expected to be negative for pupils from the lowest wealth quintile as well as the highest wealth quintile, although net learning losses remain larger for students from the lowest wealth quintile.

Figure 4. Net effect of COVID-19 and policy reforms shocks on learning outcomes, decomposed by wealth quintile



Source: Authors' estimation based on HFS (2020), NLA (2017/18), EMIS (2017/18), MICS 2014 and government policy reforms.

4.4 Effect of Economic Crisis on Education Financing

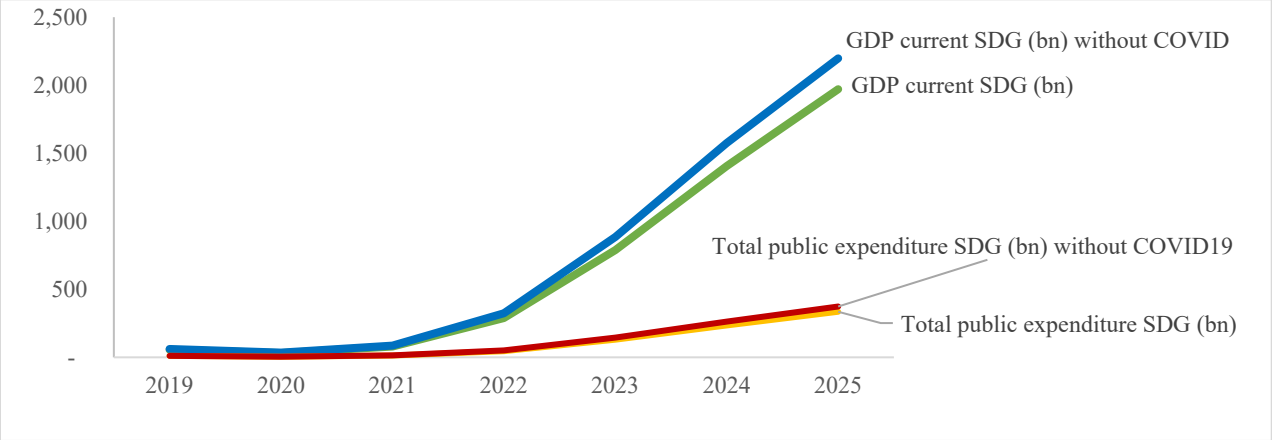
The economic ramifications from the COVID-19 pandemic are expected to further contribute to the macroeconomic challenges which have plagued the country even prior to the pandemic through rampant inflationary pressures, depreciation of its currency, and depletion of foreign exchange reserves. Although it is hard to say with certainty what the final impact will be on the education budget, the projected decrease in GDP and public spending may lead to further tightening of the

[23] To that end, several development partners are supporting Sudan's plans to strengthen distance learning modalities and school reopening protocols.

fiscal space and, in turn, impact allocations to the education budget, unless there is a clear decision to preserve spending in the social sectors such as education.

The projected trends in GDP as well as the total public expenditure, are estimated with and without accounting for the COVID-19 impact, using IMF projections until 2025. We use the GDP in constant US$ terms (base year 2010) and the real GDP growth, which the IMF revised in October 2020 to -8.4 percent, down from the pre-COVID-19 estimate of -1.2 percent from March 2020, to calculate the projections. The results indicate that real GDP is expected to be below the originally projections for 2025 by nearly 227 billion SDG. In parallel, total public expenditure, in real terms, is projected to fall by 39 billion SDG (see Figure 5).

Figure 5. Constant (2010 prices) GDP and Total public expenditure with and without COVID-19 (in billion SDG)

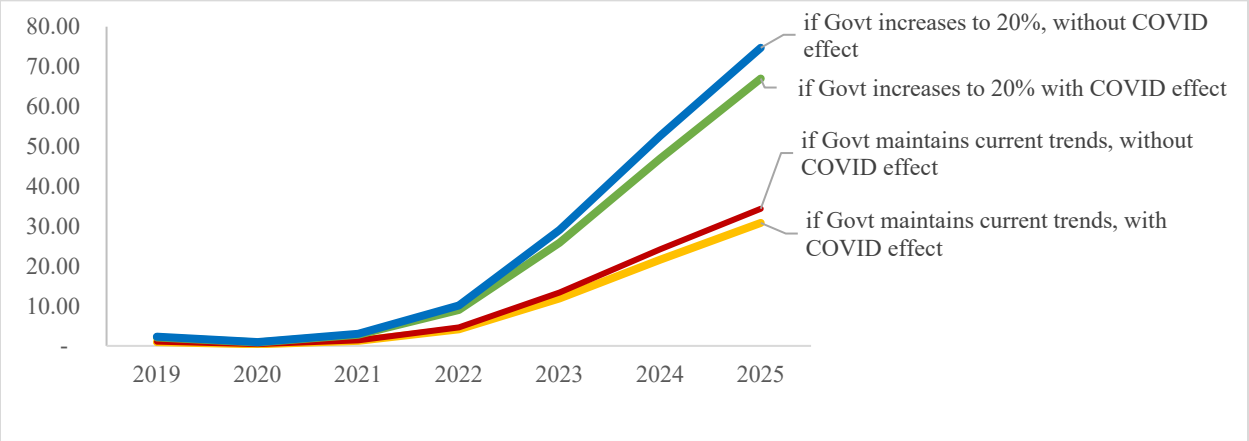


Source: Authors' projections based on IMF Article IV data

Even prior to COVID-19, education spending in Sudan was particularly low, estimated at only 9 percent of total public spending in 2018. The Government has expressed its strong commitment to increase the education budget as a share of total public spending, setting a target to increase to 20 percent by 2022. In the wake of COVID-19, it is expected to be at 12.5 percent in the FY21 budget. Education spending is simulated with and without accounting for the COVID-19 impact using the assumption of an increase to the 20 percent share of the budget (shown below).

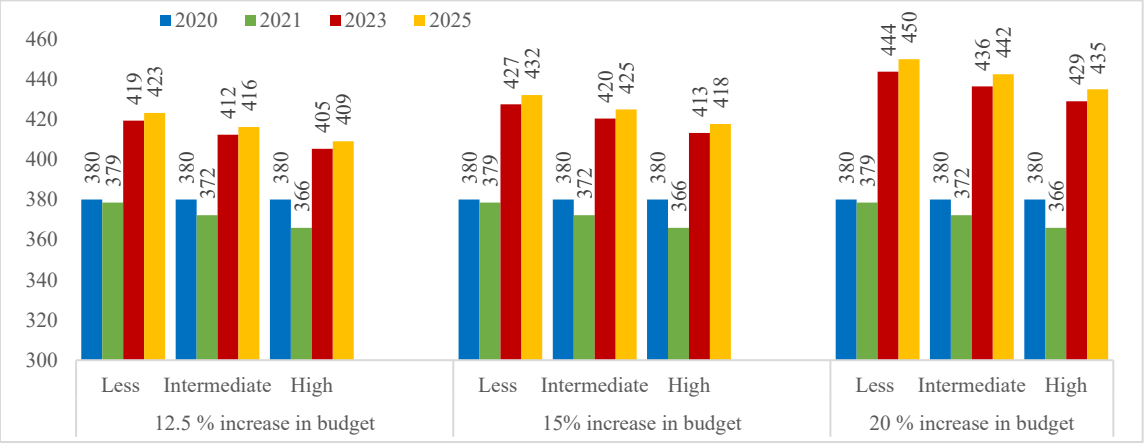
The COVID-19 impact on the economy would be expected to lead to a decrease in spending in constant prices (2010) in education from 34 to 31 billion SDG by 2025 if education spending trends continue based on the current trends. However, should the Government commit to preserving and increasing its allocation to the education sector to 20 percent of the total public spending, despite the potential effects of COVID-19 on the economy, the spending in constant prices would nearly double to over 67 billion SDG by 2025 (see Figure 6 below).

Figure 6. Constant (2010 prices) Education Spending (in billion SDG) under different assumptions



Source: Authors' projections based on IMF Article IV data, Government policy reform, and Ministry of Finance and Economic Planning (MoFEP).

Figure 7. Learning outcomes under different education budget levels, if policies are fully implemented



Source: Authors' estimation based on HFS (2020), NLA (2017/18), EMIS (2017/18), MICS 2014, government policy reforms, and Ministry of Finance and Economic Planning (MoFEP)

5. Policy options for mitigating the impact of COVID-19 on learning outcomes

In the earlier simulation of the net impact of the twin shocks on learning outcomes, two underlying assumptions are made: (i) budget allocations remain constant, and (ii) the Government is able to fully implement its reform agenda. However, on the one hand, a strong commitment to higher budget allocations (as a share and in nominal terms), closer to international benchmark recommendations of 20 percent of the total public spending, would significantly increase the resources available to the sector and support better implementation fidelity of the policy reforms. On the other hand, if the Government is unable to fully implement its agenda, especially those in the critical areas which are impactful on learning—improving teachers' qualification, expanding

access to pre-school education, and improving school environment and facilities—this would reduce the potential impact on learning outcomes.

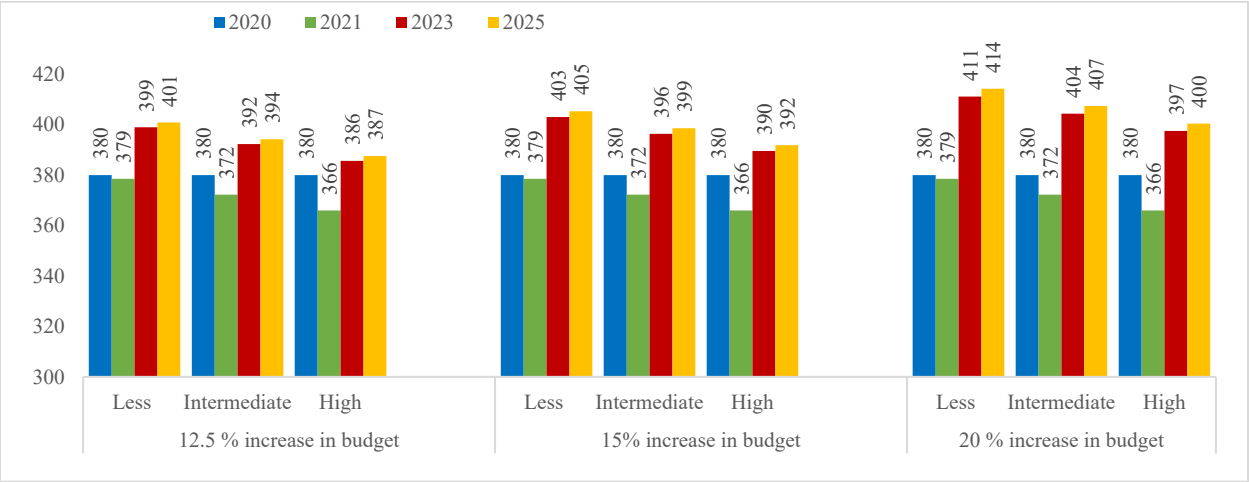
Impact of learning outcomes under alternative scenarios

To better understand the implications of preserving and even increasing the education allocation in the budget and of fully implementing the reform agenda, we consider two alternative scenarios. The first one simulates the net impact on learning outcomes under alternative budget allocations (12.5 percent, 15 percent, and 20 percent of total public spending). The second simulates the net impact on learning outcomes if the Government is only able to implement half of the policy reforms. Both scenarios are presented under the three assumptions regarding the severity of the impact of COVID-19 on learning outcomes (low-impact, intermediate, and high-impact).

The results for the first scenario (see Figure 7) indicate that, under a high-impact scenario where COVID-19 would continue to cause further significant delays, higher allocation of budget resources would be instrumental in helping curtail learning losses. Under a 12.5 percent allocation of the budget would support an increase in learning outcomes from 380 to 423 between 2020 and 2025. If the budget allocation were at 20 percent, further improvement in learning outcomes could be expected, increasing to 450 by 2025.

The projections under scenario 2 (see Figure 8) assume that there may be challenges to the full implementation of the policy reform agenda, and only about half of proposed policy reforms are implemented. The results below indicate that, should the COVID-19 impact be high, and if only half of the proposed policy actions are achieved, a higher allocation of budget resources would still help preserve learning gains. Assuming only half of the policy program is implemented, a 12.5 percent allocation of the budget would support an increase in learning outcomes from 380 to 401 by 2025. Although more modest, it would be sufficient to reduce the medium-term impact of COVID-19 on learning. With a budget allocation of 20 percent, further improvement in learning outcomes could be expected, with an increase to 414 by 2025.

Figure 8. Learning outcomes if Government achieve 50 percent the proposed policy actions as planned



Source: Authors' estimation based on HFS (2020), NLA (2017/18), EMIS (2017/18), MICS 2014, government policy reforms, and Ministry of Finance and Economic Planning (MoFEP)

Recommendations

Several lessons are drawn from the analysis presented in this paper on how to ensure that Sudan realizes its promise to improve learning outcomes, especially in the face of challenges such as the one posed by COVID-19. They include:

Limit learning loss in the short-term through effective and widely available remote learning solutions. Although measures have been taken to supply remote learning options during school closures, households, and more importantly students, are not engaging enough through these modalities, with only 10 percent of families with children in school are engaging in remote learning. Further evidence needs to be gathered on the best remote learning solutions and potentially explore the use of technology-aided remedial education programs for when students do return to school.

Provide families across Sudan with additional resources and improved connectivity to ensure remote learning is accessible to all children, especially those from poor and marginalized households. Availability of TVs and radios, a stable internet connection, and quality digital devices are necessary preconditions for digital remote learning. However, cost can be a major barrier to access. According to the Multitopic HFS, approximately 5.6 million Sudanese students (90 percent) were not engaged in any learning or education activity since school closures went into effect due to a lack of remote learning programs. Starting August-September 2020, 107 Arabic and Math lessons were produced and have been broadcasted for four hours per day on the National

TV[24]. These efforts should be strengthened to reach more children, to build a more equitable remote learning system that can be leveraged during any future school closures.

Plan policy reform well, prioritizing the most impactful reforms early and track performance. Given the breadth of the policy reform agenda envisaged, prioritizing those reform areas which are likely to have a larger impact on learning will be critical. This may mean focusing on teacher policies (teacher training and effective teacher recruitment/deployment), better school infrastructure, curriculum reform and provision of curriculum-aligned teaching and learning materials, as well as increasing access to quality early childhood education. Other reform areas may be sequenced accordingly. The literature lends support to the prioritization of these policy areas. Bashir et al. (2018) highlights that interventions that focus on a coherent instructional core—a package of well-aligned teacher training, ongoing teacher support, resources or materials for teachers, and classroom learning materials for students—has the strongest effects on learning outcomes, citing average effects of 0.28 standard deviations in interventions from Kenya, Liberia, Mali, South Africa, and Uganda. Investments in preschool have also shown to improve learning outcomes in (Kenya and Tanzania [Bietenbeck, 2019]). It is therefore critical to prioritize budget allocations to these activities as well to ensure activities are well-funded and sustainable. It is also critical to ensure implementation of reforms is carried out as intended by closely monitoring and evaluating interventions.

Target and prioritize children from the poorest household. Where appropriate, it would be important to deliberately and strategically prioritize children from the poorest households in government interventions. This may translate to, for example, targeting/prioritization of some states or localities in the first phases of rolling-out interventions, such as constructing pre-schools and early childhood education centers. Similarly, the deployment of well-qualified teachers to low performing areas could also help raise learning outcomes for the most vulnerable (Glazerman et al. (2013) and Luschei et al. (2015)).

Ensure the adequate allocation of resources to the education sector and the sustainability of financing. In 2018, Sudan spent about US$69 per child at the primary level and about US$188 per child at the secondary level[25], which is close to low-income country averages (US$68 and US$112 respectively). In comparison, lower middle-income countries spend five times as much at the primary level and two and half times as much at the secondary level. It is also well below the Sub-Saharan averages for both primary level (US$285) and secondary level (US$503) Preserving and even increasing the budget allocation to the education sector will be critical in supporting the policy reform agenda and taking appropriate measures to prevent long term learning losses. If left underfunded, learning losses may take decades to recover from.

[24] Sudan Education COVID-19 Response Project documentation, World Bank, February 2021.
[25] World Bank policy note on Education Financing in Sudan (2020)

6. Conclusions

This paper builds on two simulation models to estimate the net impact of twin shocks on the education sector: (i) the ambitious education policy reform program which was adopted by the Transitional Government as part of the broader reform agenda to improve sector performance and governance; and (ii) the effect of prolonged COVID-19 related school closures on learning loss. It also estimates the potential impact on education financing. The findings strongly suggest that potential learning losses can be remedied through appropriate interventions to boost learning outcomes. Such interventions will require a strong commitment to preserving the education sector budget and even increasing it to the international benchmark levels. The education budget increase will also help to ensure sector reforms are implemented well. At this particular crossroad for Sudan, as the country aims to rebound, both in terms of the economy as well as rebuilding its social contract with its citizens, it will be critical to ensure education remains a priority.

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Annexes

Annex A. Harmonized learning outcome

The Harmonized Learning Outcome (HLO) was developed by Harry Anthony Patrinos and Noam Angrist (2018) to generate credible cross-country and over-time comparisons of learning outcomes. The central intuition behind the methodology used was the production of a conversion factor between international standardized achievement tests (ISATs) such as PISA, TIMSS, and PIRLS and their regional counterparts (RSATs) such as SACMEQ, LLECE, and PASEC. Building on the HLO, Ritika D'Souza (2019) also developed a guide on how to calculate a subnational human capital index. For each country where HLO is calculated, the HLO exchange rate was calculated as HLO/500. The HLO use the exchange rate to convert to international scale. Below is the description of the subnational HLO calculation:

The two approaches described below can be used to convert national test scores to HLO units. The first preserves the standard deviation of the national assessment across subnational units, while the second is conceptually closer to how assessments are linked cross-nationally in the HLO database.

Method 1

1. Identify national assessment scores for the grade closest to the ISAT/RSAT. Calculate subject-level means and SDs for the national assessment. Rescale the distribution of the national assessment to have similar units to the ISAT/RSAT, separately by subject if test scores for different subjects are available in the national assessment and the corresponding ISAT/RSAT. In this example we assume that scores are available for math and language, as is the case in the Peru example provided.

$$\text{International test equivalent score}_{\text{subject}} = \left(\frac{\text{Subnational}_{\text{subject}} + \text{National mean}_{subject}}{\text{National SD}_{subject}}\right) \times \text{International SD}_{Subject} + \text{International mean}_{subejct}$$

2. Use the HLO exchange rate to convert into HLO scores

$$\text{Harmonized Learning Outcome}_{subject} = \text{nternational test equivalent scor}_{subject} \times \text{HLO exchange rate}_{subject}$$

3. Average the two subject scores to get test scores by region in HLO units if results from two tests desired

$$Harmonized\ Learning\ Outcome \frac{=(HLOmath+HLOlanguage)}{2}$$

Method 2

1. Rescale the national assessment to have a mean of 500 and standard deviation of 100

$$\text{Rescaled national assessment score } = \left(\frac{\text{subnational mean} - \text{National mean}}{National\ SD}\right) \times 100 + 500$$

2. Calculate the ratio of mean of the rescaled national assessment to the country-level HLO score as reported in the HCI country data file

$$\text{Scaling ratio} = \left(\frac{\text{scaled national assessment mean}}{National\ HLO\ score}\right)$$

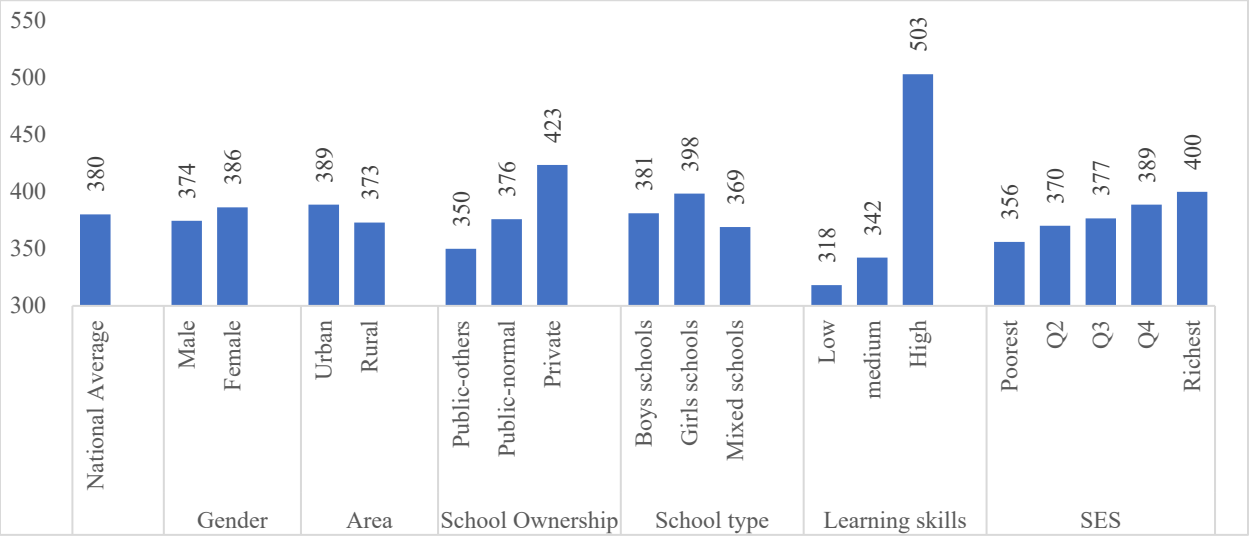
$$Scaling\ ratio = Rescaled\ national\ assessment\ mean\ National\ HLO\ score$$

3. Multiply the rescaled subnational averages of the national assessment by this scaling ratio

$$Harmonized\ Learning\ Outcome = Rescaled\ subnational\ score \times Scaling \text{ ratio}$$

For Sudan, we use the second method for the subnational HLO calculation. The HLO indicates that learning outcomes are, on average, comparable to SSA averages (380 compared to 377) but that there is considerable room for meaningful improvement in reading outcomes, especially among children from poor and vulnerable backgrounds. The breakdown of the HLO provides a closer look at the disparities across categories and provides some insightful analysis on what we know about where learning is and is not happening in Sudan. In particular, though girls tend, on average, to outperform boys, the analysis indicates that other factors related to socio-economic considerations matter. For example, learning outcomes of pupils with lower initial learning skills tend to be lower (318) than those with high initial learning skills students (503). Similarly, pupils attending schools with better facilities, as reflected in the school-level Socio Economic Status (SES), tend to outperform those from less endowed schools (400 for quintile of better endowed schools vs 356 for those from the lowest quintile). The school-level SES is composed of school-level characteristics which are proxies for the socio-economic differences between schools, for example, the availability of fences, latrines, seats, availability of school feeding, total classrooms, permanent classrooms, water, and Parent Teacher Association (PTA) contributions. indicating strong disparities stemming from children's initial learning skills, controlling for differences in school-level SES.

Figure A1. Standardized reading scores (HLO) by category



Source: Authors' estimation based on NLA 2017/18

Annex B: Determinants of learning

In order to estimate the potential effects of proposed policy reforms based on the PPF approach by Kaffenberger and Pritchett (2020), we first estimate the determinants of learning which are the drivers of the pedagogical production function. The first regression is an OLS regression with average HLO score as dependent variable, and school level characteristics as explanatory variables. A multinomial logit was run on the student learning skills, with the lowest learning skills as the reference group. The regression used the same set of independent variables to estimate the relative impact of each explanatory variable for students within each group based on the level of initial learning skills. The results indicate that some variables tend to impact learning outcomes across different cohort of pupils differently. For example, all over things remaining constant, an increase in the share teachers with a degree, results in 10.1 percent higher scores on average for the high performers (in the upper tertile) than the lowest tertile. Similarly, availability of English textbooks produces 9.2 percent higher scores on average for the upper tertile compared with the lowest tertile of pupils.

Below is a description of the independent variables used in the regression analysis. Table B1 presents summary statistics of variables used in the regressions. Table B2 present results for both regressions models.

- Average years of schooling: This is the average years of education of students in grade 1-8 in primary school. This is a proxy for the level of education of the surrounding community of the 3rd graders- it is expected that 3rd graders who evolve in a community where education is prioritized (as shown by the higher the average years of education), the better the performance on learning outcomes.
- English and Arabic textbook per child: This is the average English and Arabic textbook per child at the school
- Share of teachers with degree: This is the share of teachers at the school which have either a high school diploma or university degree
- Log of HH school support: This is the log of the PTA contributions. Taking the log of this variable allows us to consider the relative percentage change in the impact of an increase in the PTA contributions
- Share of children entering grade 1 with kindergarten: This variable captures the readiness of the children enrolling in the school, as indicated by the share of them who have attended kindergarten or pre-school
- School has electricity: This is a proxy for the level of infrastructure at the school level. A school which has access to electricity is expected to also offer better overall infrastructure, providing a conducive learning environment for the pupils
- School has access to water: This is also a proxy for the infrastructure readiness at the school level
- Ratio of volunteer teachers to teaching personnel: This indicator assesses the impact of having a larger share of volunteer teachers at the school.

- Pupil-Teacher Ratio: This variable captures the average number of pupils per teacher at the school level. The higher the PTR, is expected to negatively impact learning outcomes.
- Class size: This is the average number of pupils per class and is representative of the learning conditions in the classroom. Large class sizes are expected to impact learning outcomes negatively
- Share of forms without a classroom: This variable captures the share of grades which do have a classroom. This is also a proxy for the learning conditions of the school and the readiness of the school infrastructure. The higher the share, is expected to negatively impact the learning outcomes.

Table B1. Summary Statistics

Variable	Mean	Std.	Min	Max
Average years of schooling	4.0	0.6	1.0	6.8
English/Arabic textbook per child	0.4	0.3	0.0	2.2
Share of teachers with degree	0.3	0.5	0.0	65.0
Log of HH school support	0.7	0.3	0.0	1.0
Share of children entry grade 1 with KG	10.0	1.4	3.0	18.3
School have electricity	0.7	0.4	0.0	1.0
School have water	0.5	0.5	0.0	1.0
Share of volunteer teachers	0.9	0.2	0.0	1.0
PTR	11.6	18.2	0.0	90.0
Class size	41.9	35.6	1.9	447
Share of forms without a classroom	44.4	19.8	0.0	150

Source: Authors' estimation based on EMIS (2017/18)

Table B2. OLS Regression on Learning Outcomes

	OLS/Marginal Effect			M-Logit (ref. low learning skills)	
School-level Characteristics	Average	Male	Female	Middle learning skills	High learning skills
Average years of schooling	3.902	5.12	3.631	0.071	0.201
	(2.46)**	(2.64)***	-1.29	-1.27	(3.14)***
English// Arabic textbook per child	16.306	6.21	24.71	0.115	0.528
	(4.03)***	-1.19	(3.86)***	-0.76	(3.54)***
Share of teachers with degree	15.412	4.097	23.894	0.172	0.61
	(4.95)***	-1.01	(4.74)***	-1.57	(5.03)***
Log of HH school support	4.252	4.707	3.939	0.017	0.15
	(7.58)***	(6.69)***	(4.21)***	-0.82	(7.05)***
Share of children entry grade 1 with KG	9.665	12.597	5.564	0.136	0.355
	(4.64)***	(4.69)***	(1.67)*	(1.85)*	(4.48)***
dummy=1 if school has electricity	24.637	21.803	29.911	0.433	0.835
	(14.30)***	(9.92)***	(10.68)***	(6.92)***	(13.12)***
dummy=1 if school has water supply	2.833	3.441	3.032	0.047	0.159
	-0.94	-0.83	-0.68	-0.46	-1.27
Ratio of volunteer teachers to teaching personnel	0.173	0.119	0.238	0.007	0.01
	(3.83)***	(1.99)**	(3.44)***	(4.07)***	(5.57)***
Pupil-teacher ratio	-0.048	-0.048	-0.067	0	-0.002
	(1.91)*	-1.43	(1.75)*	-0.07	(1.95)*
Class size	-0.203	-0.154	-0.285	-0.006	-0.008
	(4.65)***	(2.76)***	(4.02)***	(3.76)***	(4.84)***
Share of forms without a classroom	-0.093	-0.063	-0.13	0	-0.005
	(2.75)***	-1.45	(2.41)**	-0.15	(3.25)***
Constant	290.02	284.955	294.237	-1.074	-3.653
	(35.88)***	(28.04)***	(21.29)***	(3.78)***	(10.92)***
F	69.336	34.472	39.277		
N	*8965*	*5472*	*3484*	*8965*	*8965*

Source: Authors' estimation based on EMIS (2017/18)) and NLA (2017/18)

Annex 3: Government reform agendas

The third step towards estimating the impact of policy reforms using the PPF model, consisted in identifying the core policy reforms, and their associated estimated impact on learning. The Government took office in late 2019 and has not had time to implement its full reform agenda, but it has clearly outlined its priority areas and actions through the annually held National Education Conference. The estimated impact of each policy reform is drawn from the literature, in particular, drawing on a Survey of Expert Opinion conducted on 40 Education Interventions in Latin American countries and six countries in Sub-Saharan Africa (Schiefelbein et al.). These are used to estimate the parameter changes in the PPF calibrated model and used to calculate the change in expected learning outcomes. Each policy action is used to simultaneously estimate the overall impact of the reforms on learning outcomes, controlling for children's initial learning level by Socio-Economic Status (SES).

The table below shows the classification of the main reform areas proposed by the Government during the National Education Conference in 2020. Six main policy areas are identified: (i) Education system; (ii) Teacher issues; (iii) Curriculum; (iv) School Environment and Technology; (v) Pre-school; and (vi) Education Financing.

Table C1: Sudan policy reform areas and policies, and expected impact on learning outcomes

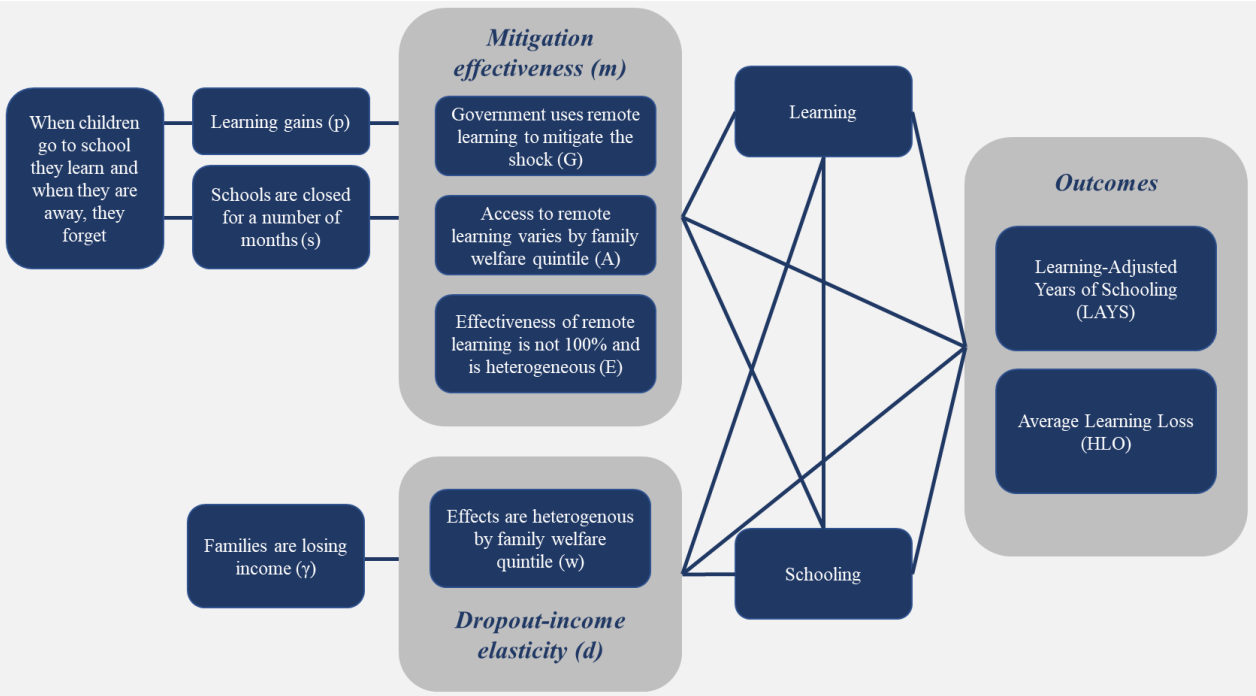
Policy area	Indicators	Impact on learning outcome (%)
A. Education system	1. Implementing free education and activating the law on compulsory primary education.	10.8
	2. Adopting the school disability inclusion policy.	12.8
	3. Establishing schools for the nomads in their places of settlement	12.8
	4. Reviewing and strengthening laws that protect teachers and curricula from political purposes	8.9
B. Teacher issues:	1. Accreditation of specialization in academic subjects at the primary level.	17.3
	2. Balanced and qualitative distribution of teachers across the board, providing states with fair opportunities for secondment.	9.5
C. Curriculum	1. Reducing the teaching materials to suit the age group by referring to the partial method	25.8
D. School environment	1. Use of technology according to individual skills and ages of students, and benefit from communication networks social in the learning process.	17.3
	2. Building laboratories and providing them with equipment and materials, an electronic library, and providing computers and display devices to apply e-learning.	11.2
E. Preschool education:	1. Attaching a kindergarten to every government school.	15.2
	2. Create an early childhood center headed by each locality	15.2
	3. Providing a unified curriculum for pre-school education that contributes to developing children's creative abilities and educational.	10.9
F. Expenditure on education:	1. Work to increase the rate of spending on education to 20 percent of the annual budget and 5 percent of the GDP.	14.4
	2. Providing the textbook printing press at the state's presidency.	15
	3. Provide budget for implementing the food culture program	16.7

Source: National Education Conference paper (2020) and Survey of Expert Opinion in Latina America and English-Speaking East and West Africa

Annex D. Model for estimating the impact of COVID-19 on learning outcomes

To simulate the impact of COVID-19 on learning outcomes, the World Bank team (Azevedo, Hasan, Goldemberg, Iqbal, and Geven, 2020) developed a simulation tool which can be customized to any country based on the length of school closure. The model simulates the potential impact of the COVID-19 pandemic and school closure on schooling, learning outcomes, and lifecycle earnings. It also assesses and accounts for the effectiveness of alternative learning programs which were rolled out to mitigate the impact of the pandemic on schooling and learning, including distance learning activities. Figure D1 shows pathways of learning loss and simulation parameters. For Sudan, due to lack of information on the impact of COVID-19 on household income, the related pathway on family effects is not captured.

Figure D1. Pathways of learning loss and simulation parameters



where,

- *p*, learning gains (school productivity) or what children learn when they go to school;
- *s*, number of months schools are closed for and children are not learning. This is an exogenous parameter based on the country context;
- *m*, mitigation effectiveness is an exogenous parameter determined by:
    - (G) Government coverage of remote learning, varying from 0-100 percent, 0 if the Government is not providing any alternative learning modality; to 100 percent if a government is supplying alternatives to the entire student population. Intermediate values can be considered if the Government is only provided content for a subset of the languages of instruction of the country; or if supply only covers certain

geographical locations of the country, leaving a share of students without any provision;

- (A) Access to alternative learning modalities, reflects the share of leaners with access to the remote learning material offered by the Government, varying from 0-100 percent. 0 if no student has access, to 100 percent if all students have access. This indicator can also capture the take-up of what is being offered by the Government through G.
- (E) Effectiveness of remote learning. This parameter ranges from 0-100 percent. 0 if the remote learning solutions are expected to have no effect, and 100 percent if those solutions are expected to be fully effective. This parameter is the one in which the greater amount of evidence needs to be built, and ideally, we would like to have the expected effectiveness of the alternative modalities offered through G.

Hence, $m = G * A * E$