

# Technical Report on Weighting and Sample Outcomes

**COVID-19: Monitoring Impacts on Learning Outcomes (MILO)**

**5 January 2022**

The Global Education Monitoring (GEM) Centre supports education stakeholders to collect, analyse and use high-quality data to improve learning outcomes. The GEM Centre is a long-term partnership between the Australian Council for Educational Research (ACER) and the Australian Government's Department of Foreign Affairs and Trade (DFAT).

# Acknowledgments

This project, the Assessment and Study of COVID Impact on Learner Progress, is referred to as the COVID-19 MILO (Monitoring Impacts on Learning Outcomes) project. This UNESCO Institute for Statistics (UIS) project is funded by the Global Partnership for Education (GPE).

The Australian Council for Educational Research (ACER) is the technical partner for this project. Support is provided from the Global Education Monitoring (GEM) Centre, an ACER initiative in partnership with the Australian government's Department of Foreign Affairs and Trade. The GEM Centre is also contributing to the UIS Global Item Bank. Technical and implementation support, and contribution to the assessment item pool, is provided by CONFEMEN.

# Table of Contents

Acknowledgments .....	2
Introduction .....	4
Section 1: Base Weights .....	4
School Base Weight (WGTFAC1) .....	5
School Base Weight Outcome Statistics .....	5
Student Base Weight (WGTFAC2) .....	5
Student Base Weight Outcome Statistics .....	6
Section 2: Adjustment for Non-Response .....	6
School non-response adjustment (WGTADJ1) .....	6
School Non-Response Adjustment Outcome Statistics .....	7
Student non-response adjustment (WGTADJ2) .....	7
Student Non-Response Adjustment Outcome Statistics .....	7
Trimming of weights .....	7
Trimmed Weights Outcomes .....	8
Final student weight (TOTWGTS).....	8
Final Student Weight Outcome Statistics .....	8
Section 3: Participation Statistics.....	9
Participation Rates .....	9
Unweighted School Participation Rate .....	9
Unweighted Student Participation Rate .....	10
Overall Unweighted Participation Rate .....	10
Weighted participation rates including substitute schools .....	11
Weighted response rates excluding substitute schools .....	12
Unweighted Response Rate Outcome Statistics .....	12
Weighted Response Rate Outcome Statistics.....	13

# Introduction

The COVID-19: Monitoring Impacts on Learning Outcomes (MILO) project aims to measure learning outcomes in six countries in Africa, in order to analyse the long-term impact of COVID-19 on learning and to evaluate the effectiveness of distance learning mechanisms utilised during school closures. In addition, this project will develop the capacity of countries to monitor learning after the crisis.

The four overarching goals of the project are to:

- Evaluate the impact of COVID-19 on learning outcomes and measure the learning loss by reporting against SDG indicator 4.1.1b
- Identify the impact of different distance learning mechanisms put in place to remediate the learning disruption generated by COVID-19
- Expand the UIS bank of items for primary education
- Generate a toolkit so that assessment results can be scaled to international benchmarks, reporting against SDG 4.1.1.b.

This document describes the methodology and processes for calculating weights and generating replicates for the purposes of variance estimation for COVID-19 MILO. In developing these methods, we have drawn from the methodologies of other large-scale international education surveys and tailored these to the specific characteristics of the COVID-19 MILO study.

Section 1 describes the process used to calculate sample weights. Section 2 describes adjustments for non-response and Section 3 explains the calculation of response rates and participation statistics. Outcomes for each participating country are included in each section, summarising the detailed outcomes reported separately in the individual country weighting outcomes reports.

## Section I: Base Weights

The final student weight is a product of several weight components, associated with each stage in the sample selection process. For COVID-19 MILO, two main weights were estimated: a School and a Student weight.

There are two components for each stage:

- *Base weights* reflect the selection probabilities of sampled units. At each level of sample selection, the base weight is the inverse of the selection probability of a sampled unit.
- *Non-response adjustments* account for the non-participation of sampled units at each stage.

## School Base Weight (WGTFAC1)

The School Base Weight reflects the probability of selection of each school within each explicit stratum.

The first stage of sampling involves selecting schools from the population. The school base weight reflects the selection probabilities of this sampling step. When explicit stratification is used, the school samples are selected independently within each explicit stratum  $h$ , with  $h=1, \dots, H$ . If no explicit strata are formed, the entire country is regarded as one explicit stratum.

A systematic sample of schools is selected with the selection probability of school  $i$  being proportional to its school size. The measure of school size ( $mos$ ) for school  $i$  in stratum  $h$  ( $mos_{hi}$ ) is based on the number of students in the target grade at that school.

The school base weight is defined as the inverse of the school's selection probability. For school  $i$  in stratum  $h$ , the school base weight,  $WGTFAC1_{hi}$ , is given by:

$$WGTFAC1_{hi} = \frac{MOS_h}{n_h^s \times mos_{hi}} \quad \text{Eq. 1}$$

Where  $n_h^s$  is the number of sampled schools in stratum  $h$ ;  $MOS_h$  is the total number of students enrolled in the schools of explicit stratum  $h$ , and  $mos_{hi}$  is the measure of size of the selected school  $i$  from stratum  $h$ .

A special case in Eq. 1 occurs when schools are relatively large so that  $mos_{hi} > (MOS_h/n_h^s)$ . These correspond to so-called 'certainty' schools, which will be selected under any circumstance. In this case, the value of  $WGTFAC1$  cannot fall below 1, so the value must be set to 1. This means the school represents only itself.

## School Base Weight Outcome Statistics

Country	Mean Base Weight	SD* Base Weight	CV** (%) Base Weight
BDI	15.83	10.04	63.45
BFA	38.62	21.89	56.67
CIV	61.05	26.93	44.11
KEN	91.14	53.79	59.02
SEN	25.89	17.90	69.14
ZMB	32.98	24.16	73.27

\* Standard Deviation

\*\* Coefficient of variation

## Student Base Weight (WGTFAC2)

In each participating school, an equal probability sample of students is selected for the survey. The Student Base Weight is the inverse of that selection probability.

For each sampled student  $j$  in school  $i$  from stratum  $h$ , the student base weight,  $WGTFAC2_{S_{hij}}$  is defined as

$$WGTFAC2_{hij} = \frac{std_{hi}}{std_{hi}^s} \quad \text{Eq. 2}$$

Where  $std_{hi}$  is the total number of eligible students enrolled in the target grade at school  $i$  from stratum  $h$ , and  $std_{hi}^s$  is the number of students sampled from that school.

### Student Base Weight Outcome Statistics

Country	Mean Base Weight	SD Base Weight	CV (%) Base Weight
BDI	4.12	4.28	103.83
BFA	2.69	2.16	80.29
CIV	2.30	1.34	58.14
KEN	3.16	2.86	90.48
SEN	3.26	2.04	62.71
ZMB	4.85	4.92	101.40

## Section 2: Adjustment for Non-Response

### School non-response adjustment (WGTADJI)

Some sampled schools might not participate in the survey or have to be removed from the dataset due to low student participation<sup>1</sup>. The school base weights are adjusted to account for the sample loss. Adjustments are calculated within non-response groups defined by the explicit strata. Within each explicit stratum, a school non-response adjustment,  $WGTADJ1_{S_{hi}}$ , is calculated for each participating school  $i$  in stratum  $h$  as:

$$WGTADJ1_{hi} = \frac{n_h^{s,e}}{n_h^p} \quad \text{Eq. 3}$$

Where  $n_h^{s,e}$  is the number of sampled eligible schools and  $n_h^p$  is the number of participating schools in the survey in explicit stratum  $h$ .

The number  $n_h^{s,e}$  in this section is not necessarily equal to  $n^s$  in the preceding section, as  $n_h^{s,e}$  is restricted to schools deemed eligible to participate in the survey. Some selected schools might turn out to no longer be eligible for participation in the survey. This happens, for example, when a school has recently closed, does not have target students in the target grade, or has only excluded students enrolled. In these cases, the ineligible school is not taken into account when calculating the non-response adjustment.

---

<sup>1</sup> See

## School Non-Response Adjustment Outcome Statistics

Country	Mean NRA	SD NRA	CV (%) NRA
BDI	1.00	0.00	0.00
BFA	1.00	0.02	1.65
CIV	1.00	0.00	0.00
KEN	1.00	0.00	0.00
SEN	1.01	0.03	3.45
ZMB	1.01	0.04	3.74

## Student non-response adjustment (WGTADJ2)

For all schools, the adjustment for student non-response for each participating student  $j$ ,  $WGTADJ2S_{hij}$  is calculated as follows:

$$WGTADJ2S_{hij} = \frac{std_{hi}^e}{std_{hi}^p} \quad \text{Eq. 4}$$

Where  $std_{hi}^e$  is the number of eligible students and  $std_{hi}^p$  is the number of participating students in school  $i$  in stratum  $h$ . In the context of student weight adjustment, students of the target population are regarded as eligible if they had not been excluded due to valid exclusions categories, according to the technical standards, including physical and intellectual disability or insufficient language experience and if they had not left the sampled school.

## Student Non-Response Adjustment Outcome Statistics

Country	Mean NRA	SD NRA	CV (%) NRA
BDI	1.05	0.07	6.67
BFA	1.04	0.10	9.16
CIV	1.04	0.07	6.91
KEN	1.02	0.04	3.84
SEN	1.02	0.04	3.62
ZMB	1.07	0.11	10.74

## Trimming of weights

A preliminary weight is calculated as the product of the base weights and non-response adjustments at each stage of selection.

$$\begin{aligned} WGT_{Prelim_{hij}} &= WGT_{FAC1_{hi}} * WGT_{FAC2_{hij}} * WGT_{ADJ1_{hi}} \\ &* WGT_{ADJ2_{hij}} \end{aligned} \quad \text{Eq. 5}$$

An analysis of the distribution of weights within each explicit stratum is undertaken to identify any outlier weights, defined as a weight that is larger than four times the

median weight for the stratum<sup>2</sup>. For most surveys, outlier weights occur rarely or not at all. They usually reflect operational issues such as problems with the sampling frame data. Outlier weights are undesirable because they open the possibility of certain sampled units having an excessive influence on survey outcomes. Large variations in weights also have a major impact on the precision of survey estimates. Any outlier weights have their weights trimmed to four times the median weight for the stratum.

## Trimmed Weights Outcomes

Country	Stratum	Students with Trimmed Weights	Student Base Weight	Student NRA	Median Weight	Prelim Weight	Final weight
BFA	03	20	2.5	1.00	55.24	241.66	220.94
SEN	01	20	5.05	1.00	61.08	333.15	244.33
SEN	02	19	7.15	1.05	49.58	268.16	198.30
SEN	15	20	3.85	1.00	53.89	221.64	215.55
ZMB	02	19	9.00	1.05	90.40	536.09	361.59
ZMB	06	16	3.95	1.25	81.96	429.39	327.85

## Final student weight (TOTWGTS)

The final student weight,  $TOTWGTS_{hij}$ , of each student  $j$  of school  $i$  in stratum  $h$  is the product of the four weight and non-response adjustment components with any necessary weight trimming applied:

$$TOTWGTS_{hij} = WGT_{Prelim_{hij\_trimmed}}$$

Eq. 6

## Final Student Weight Outcome Statistics

Country	N (Participants)	Mean Final Student Weight	SD Final Student Weight	CV (%) Final Student Weight
BDI	4677	44.04	12.81	29.08
BFA	4629	85.27	40.65	47.67
CIV	4643	120.82	35.51	29.39
KEN	5880	189.96	36.09	19.00
SEN	4541	60.24	29.31	48.65
ZMB	4403	98.32	43.14	43.88

<sup>2</sup> This definition is based on a convention used in most large-scale educational surveys.



## Section 3: Participation Statistics

During data collection, some sampled schools and students may, for various reasons, not participate in the survey. In some instances, selected schools may turn out to have no eligible students or may have recently closed. In the context of a large-scale educational survey, it is not unusual to find a small number of such instances. In effect, the survey has uncovered an aspect of the dynamic nature of an educational system, for example a school closure since the time the sampling frame was developed. In other cases, the school has eligible students but refuses or is unable to participate. In these cases, a similar school, systematically assigned at the time of school sampling, may be used as a substitute. If neither the sampled school nor an assigned substitute school participates, the sampled school is classified as a non-respondent.

According to the COVID-19 MILO Technical Standards, rates within schools will be measured against certain benchmarks, with consequences when these rates fall to low levels, because of the increased risk of non-response bias in these situations. If fewer than 50% of sampled eligible students respond to the survey, the school is considered as a non-respondent for the purpose of estimating participation rates<sup>3</sup>. Furthermore, schools with less than 25% student participation are removed from the database and weights for the remaining schools from the stratum are adjusted to take into account their non-response<sup>4</sup>.

Within participating schools some students may be found to be ineligible, or may be identified as within-school exclusions, for example because of a functional or intellectual disability or insufficient language experience<sup>5</sup>. Other students may not participate due to absence or refusal. All eligible students in the school are classified as non-respondents if they are absent from the survey session or are present but do not manage to complete at least 10% of the of the assessment items<sup>6</sup>.

### Participation Rates

COVID-19 MILO will report weighted and unweighted participation rates for schools and students, as well as overall participation rates that are a combination of both. To distinguish between participation based solely on originally sampled schools and participation that also relies on substitute schools, school and overall participation rates will be computed separately for originally sampled schools only and for originally sampled together with substitute schools.

### Unweighted School Participation Rate

The unweighted school participation rate is the ratio of the number of participating schools to the number of originally sampled schools, excluding any sampled schools

---

<sup>3</sup> Technical Standards COVID-19: Monitoring Impacts on Learning Outcomes (MILO), Standard 1.12, Note 1.3

<sup>4</sup> Technical Standards COVID-19: Monitoring Impacts on Learning Outcomes (MILO), Standard 1.12, Note 1.2

<sup>5</sup> Technical Standards COVID-19: Monitoring Impacts on Learning Outcomes (MILO), Standard 1.12, Note 1.5

<sup>6</sup> Technical Standards COVID-19: Monitoring Impacts on Learning Outcomes (MILO), Standard 1.12, Note 1.1

found to be ineligible. A school is considered to be a participating school if it has a student participation rate of at least 50 percent. The two unweighted school participation rates are calculated as follows:

$R_{unw}^{sc-s}$  unweighted school participation rate for originally sampled schools only

$R_{unw}^{sc-r}$  unweighted school participation rate, including originally sampled and first and second substitute schools

$$R_{unw}^{sc-s} = \frac{n_s}{n_s + n_{sub1} + n_{sub2} + n_{nr}} \quad \text{Eq. 7}$$

$$R_{unw}^{sc-r} = \frac{n_s + n_{sub1} + n_{sub2}}{n_s + n_{sub1} + n_{sub2} + n_{nr}} \quad \text{Eq. 8}$$

Where  $n_s$  is the number of sampled participating schools;  $n_{sub1}$  and  $n_{sub2}$  are respectively the first and second substitute schools that participated in the survey; and  $n_{nr}$  the number of sampled schools that did not participate and were not able to be replaced by their corresponding substitute schools<sup>7</sup>.

## Unweighted Student Participation Rate

The unweighted student participation rate is the ratio of the number of selected students that participated in COVID-19 MILO to the total number of eligible, sampled students from the participating schools. The unweighted student participation rate  $R_{unw}^{st}$  is computed as follows:

$$R_{unw}^{st} = \frac{\sum_{i,j}^{s+sub1+sub2} S_{rs}^{i,j}}{\sum_{i,j}^{s+sub1+sub2} S_{rs}^{i,j} + \sum_{i,j}^{s+sub1+sub2} S_{nr}^{i,j}} \quad \text{Eq. 9}$$

Where  $S_{rs}^{i,j}$  is the number of respondent students from school  $j$  in stratum  $i$ ;  $S_{nr}^{i,j}$  the number of non-respondent eligible students from school  $j$  in stratum  $i$ .

## Overall Unweighted Participation Rate

The overall unweighted participation rate is the product of the unweighted school and student participation rates. Because COVID-19 MILO will compute two versions of the unweighted school participation rate, one based on originally sampled schools only and the other including substitutes as well as originally sampled schools, there also are two overall unweighted participation rates:

$R_{unw}^{ov-s}$  unweighted overall participation rate for originally sampled schools only

---

<sup>7</sup> This number includes those schools that participated but the student response rate fell below 50% of eligible students sampled for the survey.

$R_{unw}^{ov-r}$  unweighted overall participation rate, including originally sampled and first and second substitute schools

$$R_{unw}^{ov-s} = R_{unw}^{sc-s} \times R_{unw}^{st} \quad \text{Eq. 10}$$

$$R_{unw}^{ov-r} = R_{unw}^{sc-r} \times R_{unw}^{st} \quad \text{Eq. 11}$$

## Weighted participation rates including substitute schools

For the weighted response rates, sums of weights are used instead of counts of schools and students. School and student base weights (BW) are the weight values before correcting for non-response, so they generate estimates of the population being represented by the responding schools and students. The final weights (FW) at the school and student levels are the base weights corrected for non-response.

### Weighted school response rate including substitutes

School response rates are computed as follows:

$$RR_3^{sc} = \frac{\sum_i^{s+sub1+sub2} (BW_i \times \sum_j^{r_i} (FW_{ij}))}{\sum_i^{s+sub1+sub2} (FW_i \times \sum_j^{r_i} (FW_{ij}))} \quad \text{Eq. 12}$$

Where  $i$  indicates a school,  $s + sub1 + sub2$  all responding schools,  $j$  a student, and  $r_i$  the responding students in school  $i$ . First, the sum of the student final weights  $FW_{ij}$  for the responding students from each school is computed. Second, this sum is multiplied by the school's base weight (numerator) or the school's final weight (denominator). Third, these products are summed over the responding schools (including substitute schools). The ratio of these values is the response rate.

### Weighted student response rate including substitutes

The student response rate is computed over all responding schools. Of these schools, the population represented by the responding students is divided by the population being represented by the schools of those responding students. The numerator of the school response rate calculation (Equation 14) is the denominator of the student response rate:

$$RR_3^{st} = \frac{\sum_i^{s+sub1+sub2} (BW_i \times \sum_j^{r_i} (BW_{ij}))}{\sum_i^{s+sub1+sub2} (BW_i \times \sum_j^{r_i} (FW_{ij}))} \quad \text{Eq. 13}$$

### Overall weighted student response rate including substitutes

The overall response rate is the product of the school and student response rates:

$$RR_3 = RR_3^{sc} \times RR_3^{st} \quad \text{Eq. 14}$$

## Weighted response rates excluding substitute schools

Practically, substitute schools are excluded by setting their school base weight to zero and applying the same computations as above. More formally, the parts of the response rates are computed below.

### Weighted school response rate excluding substitutes

$$RR_4^{sc} = \frac{\sum_i^s (BW_i \times \sum_j^{r_i} (FW_{ij}))}{\sum_i^{s+sub1+sub2} (FW_i \times \sum_j^{r_i} (FW_{ij}))} \quad \text{Eq. 15}$$

### Weighted student response rate excluding substitutes

$$RR_4^{st} = \frac{\sum_i^s (BW_i \times \sum_j^{r_i} (BW_{ij}))}{\sum_i^s (BW_i \times \sum_j^{r_i} (FW_{ij}))} \quad \text{Eq. 16}$$

### Overall weighted student response rate excluding substitutes

$$RR_4 = RR_4^{sc} \times RR_4^{st} \quad \text{Eq. 17}$$

## Unweighted Response Rate Outcome Statistics

Country	School Response Rate (Ex Substitutes)	School Response Rate (Inc Substitutes)	Student Response Rate (Ex Substitutes)	Student Response Rate (Inc Substitutes)	Overall Response Rate (Ex Substitutes)	Overall Response Rate (Inc Substitutes)
BDI	100%	100%	95%	95%	95%	95%
BFA	88%	100%	84%	84%	74%	84%
CIV	99%	100%	96%	96%	95%	96%
KEN	100%	100%	98%	98%	98%	98%
SEN	95%	99%	98%	98%	93%	97%
ZMB	63%	99%	93%	93%	59%	92%*

\*After alternative provisions were implemented. Please see individual country weighting reports for details. 16 sampled schools were assigned a non-standard school participation code (15), to allow for the collection of substitute school data under exceptional circumstances.

## Weighted Response Rate Outcome Statistics

Country	School Response Rate (Ex Substitutes)	School Response Rate (Inc Substitutes)	Student Response Rate (Ex Substitutes)	Student Response Rate (Inc Substitutes)	Overall Response Rate (Ex Substitutes)	Overall Response Rate (Inc Substitutes)
BDI	100%	100%	95%	95%	95%	95%
BFA	84%	100%	94%	94%	79%	94%
CIV	99%	100%	95%	95%	95%	95%
KEN	100%	100%	98%	98%	98%	98%
SEN	93%	99%	98%	98%	91%	97%
ZMB	60%	99%	93%	93%	56%	91%*

\*After alternative provisions were implemented. Please see individual country weighting reports for details. 16 sampled schools were assigned a non-standard school participation code (15), to allow for the collection of substitute school data under exceptional circumstances.