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### Working Paper Determinants of student performance during the COVID-19 pandemic school closure in Bhutan

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# DETERMINANTS OF STUDENT PERFORMANCE DURING THE COVID-19 PANDEMIC SCHOOL CLOSURE IN BHUTAN

Ryotaro Hayashi, Xylee Javier, David Raitzer, and Milan Thomas

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#### ABSTRACT

This paper uses value-added models and panel data from a comprehensive set of highstakes secondary school exams to assess determinants of student performance during the coronavirus pandemic in Bhutan. Gender gaps, urban–rural gaps, and socioeconomic gaps do not appear to have widened substantially after the pandemic-related closure. Student characteristics (gender, access to a computer at home) and school characteristics (boarding facilities, urban location, class size, computers) predict performance. Quantile regression analysis shows that home learning environment (parental education) is a predictor of Class XII performance for higher-performing Class X students. Computer ownership at home clearly improves English performance but the pattern is less clear for Dzongkha, which has limited software and internet content for instruction. Influence of past performance and gender is stronger for students in the lowperforming group. Boarding facilities played a unique role in Bhutan's pandemic response, potentially mitigating learning losses and offsetting household differences that condition education outcomes.

Keywords: education, distance learning, school closures

JEL codes: 124, 128

#### I. INTRODUCTION

#### A. COVID-19 Pandemic School Closures and Learning Loss

At the peak of the coronavirus disease (COVID-19) pandemic in 2020, 1.6 billion students were unable to attend class, as schools were closed to prevent viral transmission (Azevedo et al. 2021). The impact of periods of closure during the pandemic has become the subject of extensive economic research. This includes investigation of how the closures differentially affected demographic groups (such as male vs female, rich vs poor, high vs low performers, etc., Hammerstein et al. 2021). In this paper, we present the first analysis of relative learning losses for Bhutan.

The pandemic has subsided, and education systems have mostly returned to normal. New data reveal the extent of damage that school closures have caused. A systematic review of learning loss<sup>1</sup> research by Donnelly and Patrinos (2022) found that seven out of eight studies showed evidence of student learning loss. Additionally, four of the studies observed increases in inequality, with certain groups of students experiencing larger learning losses than others.

In a more recent meta-analysis, Dela Cruz et al. (2024) find that, in developing countries, a year of school closure led to learning loss equivalent to 1.1 years' worth of learning. However, reopening schools reduced these losses to 0.5 years. The relationship between learning loss and the duration of closure is stronger for mathematics and science subjects in the absence of reopening than for reading, literacy, and language subjects, with a 1.1-year difference for every year of closure. Interestingly, the mitigating effect of reopening is not stronger for mathematics and science. Additionally, the study reveals that primary students experienced greater learning loss from school closure than did secondary students, but the mitigating effect of reopening was similar. Furthermore, learning losses as a result of school closures in developing countries were at least twice as large as those in developed countries, attributed to longer school closures. According to simulations by Azevedo et al. (2022), learning-adjusted years of schooling (LAYS)<sup>2</sup> decreased by 1.1

<sup>&</sup>lt;sup>1</sup> The term "learning loss" refers to a decrease in knowledge or skills, or a slowdown or interruption in academic advancement. This is typically caused by extended breaks or disruptions in a student's education. There are two main types: "forgetting," which is the loss of previously acquired learning, and "forgone" learning, which means the expected learning that does not occur when schools are closed for in-person learning (World Bank, UNESCO, and UNICEF 2021).

<sup>&</sup>lt;sup>2</sup> Learning losses can be measured using LAYS, which take into account both the quantity and the quality of education. School closures impact LAYS in three ways: (i) the absence of distance learning and remedial education for each year of school closure reduces expected years of completed schooling (quantity), leading to a linear effect on learning (Filmer et al. 2020 as cited in ADB 2022). This loss can be lessened by providing continued remote education while schools are physically closed; (ii) school disruptions, combined with economic shocks, result in more student dropouts, thereby reducing average expected years

years, and the percentage of youth below minimum proficiency on the Programme for International Student Assessment (PISA)<sup>3</sup> is projected to increase by 12.3 percentage points.

These learning losses have clear economic implications. The economic impact of school shutdowns could lead to a loss of \$21 trillion in lifetime earnings in present value. These aggregate losses will not be shared equally. Limited access of poor students to remote instruction during the pandemic has widened learning disparities between rich and poor. The poorest quintile of students is expected to experience 47% more in projected earning losses than the richest quintile of students in developing Asia. Expected losses in girls' future earnings are 28% higher than they are for boys in developing Asia (ADB 2022).

### B. COVID-19 Pandemic School Closures in Bhutan

Before the pandemic, Bhutan's education system performed relatively well. Its students' performance was on par with the top PISA-D countries in 2017 (BCSEA and OECD 2019).

Bhutan stands out as a South Asian country that limited school closures during the pandemic (Gough 2020). Its closure period lasted from March to December 2020 but had varying impacts on different grade levels (Table 1). In July 2020, in-person instruction resumed for Class X and Class XII students only (UNICEF and UNESCO 2021). This means that the closure period was relatively short for 10th and 12th graders (4.5 months, versus 9 months for all other students). Bhutan's proactive approach in managing learning losses under COVID-19 makes it an interesting case study, particularly when compared with that of many other developing countries in Asia.

of schooling for a country; and (3) school closures diminish the quality of learning via the inefficiency of remote education compared with in-person classes (ADB 2022).

<sup>&</sup>lt;sup>3</sup> PISA, conducted by the Organisation for Economic Co-operation and Development (OECD), assesses 15-year olds' skills in reading, mathematics, and science to tackle real-life challenges. <u>www.oecd.org/en/about.html</u>.

 Table 1: The Education System of Bhutan

LEVEL	Early Child Care and Development	Pre-Primary, I, II, III, IV, V, VI	VII, VIII, IX, X		XI, XII	1st, 2nd, 3rd, 4th Year
ISCED	0	1	2	2	3	5
		Primary Education (5-11 years)	Secondary	education (12	2-17 years)	Tertiary Education (18- 22 years)
	ECCD Centers			Middle Secondary	Higher Secondary School	Undergraduate Courses
Туре		Primary School	Lower Secondary	School	Continuing Education	Chaolgradate Coulooc
			School		Nonforma	I Centers
					Vocational E	ducation System (TTI/IZC) [ISCED 3-4]
					Labor Market	

ECCD = early childhood care and development, ISCED = International Standard Classification of Education, IZC = Institute of Zorig Chusum, TTI =Technical Training Institute.

Source: Adopted from Ministry of Education and Skills Development (2021).

During the pandemic, the government gave priority to in-person instruction for Class X and XII students because of the high-stakes exams they were scheduled to take at the end of the year. Results in Class X and Class XII nationally standardized exams determine the higher education options available to students. Class X students are required to study three subjects: Dzongkha, English, and Science. These subjects also have a high rate of continuation for Class XI and Class XII, as Dzongkha and English are compulsory, while science (chemistry and physics) is a core subject for the Science stream students.

Additionally, the government implemented measures to lessen the impact of school closures for students at all grade levels. These measures included providing financial assistance to vulnerable households, supplying hardware and programming for remote instruction (using radio, TV, online apps, social media, and print media), and curriculum reform. TV lessons provided by Bhutan Broadcasting Services were the primary mode of instruction during closures, and 71% of schools used social media to supplement these lessons. Curricula for all grade levels were restructured to focus on two-thirds of the material considered essential by a curriculum committee (Ministry of Education and Skills Development, Helvetas Bhutan, and UNICEF 2021).

However, the closure of schools in 2020 for Class X and XII students still significantly disrupted a critical year of their education. Despite efforts to maintain normal instruction for secondary school students, they had less time for catch-up learning in the education system. For nearly 5 months, secondary school students had to rely on imperfect

substitutes for in-person instruction. TV instruction was offered for fewer hours compared with classroom instruction, and only 60% of Bhutanese households have internet access (UNICEF and UNESCO 2021).

Efforts were made to ensure fairness and to support the most vulnerable students during school closures. These efforts included providing printed self-instruction materials and expanding boarding facilities to enable continued education for students from both rural remote areas and urban high-risk areas. However, it is possible that disadvantaged students suffered the most during COVID-19, in terms of both household socioeconomic status and pre-closure learning outcomes. This would be consistent with findings from other countries (Moscoviz and Evans 2022).

#### II. STUDY OBJECTIVE

Research is needed to understand the extent to which school closures disrupted Bhutanese learning outcomes. This study of Bhutan's experience focuses on the interaction of student and school characteristics as determinants of learning progression, identifying factors that helped mitigate the impact of the school closure.

The remaining sections of the paper are organized as follows: Section III details the study's design and data sources; Section IV discusses the empirical specifications employed in the study; Section V presents the results; Section VI presents additional concerns and robustness checks; and, finally, Section VII concludes with policy recommendations.

### III. STUDY DESIGN AND DATA

This study analyzes the performance of students who were in Class XI during the 2020 school closure, using the high-stakes examinations taken at the end of Class X and Class XII grade (Bhutan Certificate of Secondary Education—BCSE—and Bhutan Higher Secondary Education Certification—BHSEC, respectively). After describing absolute performance and noting its limitations as a measure of learning loss, we move on to analyzing relative performance and its implications for equity in Bhutanese education.

Data were collected at two levels to investigate school closures:

(i) Student-level data: The Bhutan Council for School Examinations and Assessments (BCSEA) provided BCSE and BHSEC exam score data for Class X and Class XII students between 2019 and 2021. These exams are the only national standardized exams in Bhutan. The exams were administered in December 2019 in a normal year, while in 2021 schools reopened but there was a delay in exams until February 2022. The data include limited demographic information on the test takers.

In the 2021 data, information from a survey sample of 21,882 Class X and Class XII students was combined with the test score data. The survey collected information on sex, location, age, school, and other demographics in an online survey conducted by the Asian Development Bank (ADB) in 2021. Matching of the survey and test score data was carried out based on name, sex, and birthdate. A 70% match rate was achieved.

(ii) School-level data: Bhutan's Education Management Information System (managed by the Ministry of Education and Skills Development) provided data from 2022 on school characteristics such as enrolment, facilities, and teachers. The accuracy of the data was confirmed through a school administrators' survey conducted during school visits in April 2023.

The study included only students who had remained in school and progressed from Class X to Class XII between 2019 and 2021, as test scores in both periods are otherwise unavailable. This may underestimate loss, as students who struggled severely may have dropped out of school or repeated a grade during the period.

#### A. Summary Statistics on Demographics

Table 2 presents descriptive statistics on student, household, and school characteristics. The sample includes only students from public schools, as data on school characteristics from most private schools are not available. We therefore use the subsample of public school students, totaling 4,792 observations.

Variable	Obs	Mean	Std. Dev.	Min	Мах
Student and household characteristics					
Class XII English score	4,792	49.63	9.69	21.71	81.14
Class X English score	4,792	46.50	8.23	22.50	71.50
Class XII Dzongkha score	4,789	50.46	10.01	8.00	77.71
Class X Dzongkha score	4,789	49.58	8.78	14.88	73.13
Student is male	4,792	0.43	0.49	0	1.00
Student has access to computer at home	4,792	0.41	0.49	0	1.00
Student has access to mobile phone at home	4,792	0.98	0.14	0	1.00
Student has access to television at home	4,792	0.89	0.31	0	1.00
At least one parent completed at least higher secondary education	4,792	0.15	0.36	0	1.00
At least one parent completed at least middle or lower secondary education	4,792	0.12	0.33	0	1.00
Number of siblings	4,792	3.51	2.11	0	10.00

Table 2: Descriptive Statistics for Sample Students Used in Regressions

Continued on the next page

Variable	Obs	Mean	Std. Dev.	Min	Max
School characteristics					
School has boarding facilities	4,792	0.69	0.46	0	1.00
School is located in urban area	4,792	0.52	0.50	0	1.00
Class XII class size	4,792	29.38	4.02	19.50	38.33
Number of Class XII English teachers	4,792	2.39	1.08	0	5
Number of computers available to all students	4,792	71.20	26.29	0	190

Source: Authors' calculations based on BCSEA data (public school students).

About 43% of students in the public schools were male, indicating a significant gender gap in Bhutan's secondary education. Regarding access to technology at home, only 41% of students had access to a computer, 89% had access to a television, and almost all (98%) had access to a mobile phone. As public education is relatively new in Bhutan, most students still had parents who are uneducated. Only 15% of students had at least one parent with a high school diploma, while 12% had parents who had only finished elementary education. This suggests that the majority of students may lack academic support at home. The average number of siblings among the students analyzed was three to four. Additionally, almost 70% of students in the sample were attending schools with boarding facilities, and 52% of schools were in urban areas.

The average class size for Class XII students was 29, while the average number of Class XII English teachers per school was 2. In addition, the average number of computers available for all students school-wide was 71. However, limited data availability means we are unable to accurately determine the average number of computers available to Class XII students during their computer classes. This is because we cannot exclude computers available to other non-Class XII students and computers in other areas, such as in libraries or dorms.

#### B. Summary Statistics on Test Scores

BSCE and BHSEC assessment comprises a theory component (a written exam) and a continuous assessment component (homework). Only the theory component is scored by a central authority, so this is the basis for the analysis. Furthermore, the analysis maintains a focus on English and Dzongkha as these are compulsory for both Class X and Class XII. As Table 2 shows, the average English score for Class XII is 49.6; for Class X, it is 46.5. The average Dzongkha score for Class XII is 50.5; for Class X, it is 49.6.

Figure 1 shows that average scores dropped somewhat from 2020 to 2021. However, given changes in exam content from year to year and contemporaneous changes in assessment policies, it is inappropriate to use test scores to assess absolute learning losses from year to year. The curricula for all years were streamlined in 2020 and

standards were adjusted. This is why the focus of much of the study is on relative performance.





Note: Dzongkha is the national language of Bhutan.

Source: Authors' calculation based on BCSEA data (all students).

#### C. Performance Gaps Between Demographic Groups

In 2019, there were significant performance gaps based on sex (Figure 2), geographical location (Figure 3), access to computers at home (Figure 4), and type of school (Figure 5). Female Class X students outperformed boys by 2.38 points in Dzongkha and 1.37 points in English. Urban school students in Class X outperformed rural school students by 0.65 points in Dzongkha and 1.98 points in English. In Class X, students with computers at home outperformed those without by 4.41 points in English. Additionally, students in schools with boarding facilities scored 4.27 higher in Dzongkha compared with students in schools without boarding facilities. The overall pre-closure performance gaps did not widen substantially when the students were in Class XII after the closure in 2021.

The following section conducts a deeper exploration of the drivers of exam performance at the student and school level through linear and quantile regression analysis.



Figure 2: Gaps in Achievement by Sex, 2019 vs 2021



Figure 3: Gaps in Achievement by Geographical Location, 2019 vs 2021



Figure 4: Gaps in Achievement by Computer Access, 2019 vs 2021





#### IV. EMPIRICAL STRATEGY

This study analyzes exam performance using value-added models (VAMs) of achievement production. Singh (2015) provides a comprehensive explanation of the attractive properties of VAM approaches and their ability to provide causal inference that approximates that of randomized approaches because lagged test scores capture most elements of selection bias. This section outlines the empirical framework for estimating these models. Citing Todd and Wolpin (2003, 2007) as mentioned in Singh (2015), achievement production can generally be expressed as follows:

$$\gamma^*_{ist} = F|X_i(t), S_i(t), \mu_{is0}, \epsilon_{ist}|$$

where achievement ( $\gamma^*_{ist}$ ) of a child (*i*) in school (*s*) at time (*t*) can be represented as a function of various factors, including history of home-based inputs  $X_i(t)$ , school-based inputs  $S_i(t)$ , student endowments such as mental ability ( $\mu_{is0}$ ), and a time-varying error term ( $\epsilon_{ist}$ ).

However, the above equation cannot be directly estimated because we usually do not observe the complete history of home and school inputs as well as individual endowments of students, such as cognitive ability. To account for all previous inputs and any past unobservable endowments and shocks, we can use a lagged or dynamic ordinary least square (DOLS) VAM.

For this paper, to assess student and school determinants of performance after school closures, a dynamic OLS VAM was used with the core specification for estimation as follows:

$$Y_{it} = \alpha + \beta_1 \cdot Residential_{it} + \beta_2 \cdot Site_i + \beta_3 \cdot X_{i,t} + \beta_4 \cdot Y_{it-1} + \beta_5 \cdot Z_{it} + \epsilon_{it}$$

where *Residential*<sub>*it*</sub> is an indicator variable equal to 1 if the student (*i*) at time (*t*) is enrolled in a school with boarding facilities; *Site*<sub>*i*</sub> is a vector of dzongkhag (district) dummy variables; *X* is a vector of student background characteristics (including sex of student, access to computer/phone/television at home, parental education, number of siblings);  $Y_{it-1}$  is the Class X raw test score; *Z* is a vector of other school characteristics (including urban location, class size, teacher–student ratio, computer–student ratio); and  $\epsilon_{it}$  is the error term.

This study uses a similar approach to that in Singh (2015), with some variations in the details owing to differences in data availability and limitations. One notable difference from Singh (2015) is that this paper includes more school-related variables, but it lacks time-use variables, which represent number of hours spent on various activities on a

typical day, such as caring for others, household chores, time at school, after-school activities, paid or unpaid work outside the household, leisure activities, and sleeping.

The estimations in the linear regression analysis involve four models using student and household characteristics, plus current school characteristics. The first model incorporates previous academic performance in the same subject as an indicator of students' attributes, household resources (e.g., access to technology at home like computers, TVs, and mobile phones; and having at least one parent with at least a high school education), and school fixed effects. The second model utilizes school characteristics such as location in an urban area and availability of boarding facilities for students, instead of using dummy variables to adjust for school fixed effects. It also includes measures of various school resources for students' education, such as number of teachers and computers available to students. The third model builds upon the second model by introducing dzongkhag (district) fixed effects. This takes into account potential geographic effects that the school-specific characteristics in Model 2 do not capture. Lastly, the fourth model builds upon the third model by including interaction terms between select household characteristics and enrollment in residential schools.

Next, we conduct quantile regression to explore how school characteristics are correlated with student performance across different levels of achievement (as of Class X): low (Q25), medium (Q50), and high (Q75) performers. This analysis aims to demonstrate how student and school characteristics vary across the achievement spectrum.

Finally, a set of regressions was analyzed to control for school inputs in both Class X and Class XII. This analysis allows for an examination of the characteristics of schools previously attended, taking into account the school inputs available to students before the pandemic. This set of regressions is further discussed in Section VI (*Robustness Checks*).

### V. RESULTS

#### A. Linear Regression Analysis

Table 3 presents the analysis of factors that predict performance in Class XII using valueadded regressions. It displays the impact of student and household characteristics on academic performance and illustrates the effect of current school characteristics. It is important to note that, in the analysis, where school characteristics were controlled for both Class X and Class XII schools, the school characteristics reflect data as of 2022, which may differ from conditions during the pandemic. Additionally, there was a significant drop in the number of observations owing to missing values in the number of Class X English teachers.

#### Student and Household Characteristics

The results indicate that students' academic success is significantly influenced by their previous academic performance, as expected for a value-added specification. After accounting for previous performance, certain student and school characteristics are associated with students' post-closure performance.

Having a computer or mobile phone is linked to better overall academic performance. Access to a computer at home significantly improves the performance of Class XII students in English. The same goes for Dzongkha but only after the introduction of residential interaction terms. One of the challenges faced during the pandemic was lack of online materials for Dzongkha, the official language of Bhutan. Students also encountered difficulties in viewing files that required Dzongkha software, which may not be installed on their computers (Ministry of Education and Skills Development, Helvetas Bhutan, and UNICEF, 2021). Nonetheless, regression results show that having access to a mobile phone enhances Dzongkha scores. This is consistent with a study by Rai et al. (2018), which found that respondents preferred to use mobile applications when learning Dzongkha.

In addition, having at least one parent who completed high school is positively associated with students' English grades. Number of siblings at home is negatively associated with English performance, perhaps because distractions at home hamper students' ability to study. However, these characteristics were not significant for Dzongkha performance.

In Model 1, several characteristics are strong predictors of Class XII exam performance as presented in Table 3. These include sex, Class X performance, home computer access, parental education, and number of siblings.

#### Table 3: Linear Regression Results for English and Dzongkha Exam Scores

Variable		Class XII E	nglish Score			Class XII Dzo	ongkha Scor	e
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Dependent variable: Class XII test scores	49.43	49.63	49.63	49.63	50.85	50.46	50.46	50.46
Student and household characteristics								
Class X English score	0.908***	0.916***	0.915***	0.915***				
	(0.010)	(0.011)	(0.011)	(0.011)				
Class X Dzongkha score					0.851***	0.902***	0.865***	0.864***
					(0.009)	(0.010)	(0.009)	(0.009)
Student is male	-0.833***	-0.868***	-0.834***	-0.837***	-0.697***	-0.680***	-0.683***	-0.687***
	(0.149)	(0.164)	(0.161)	(0.161)	(0.145)	(0.169)	(0.158)	(0.158)
Student has access to computer at home	0.686***	0.846***	0.723***	1.063***	0.126	0.095	0.229	1.028***
	(0.174)	(0.189)	(0.187)	(0.327)	(0.168)	(0.191)	(0.182)	(0.319)
Student has access to mobile phone at home	0.593	0.760	0.777	0.743	1.195**	1.441**	1.491***	1.447**
	(0.543)	(0.602)	(0.588)	(0.588)	(0.526)	(0.614)	(0.575)	(0.575)
Student has access to television at home	0.165	0.177	0.197	0.238	-0.274	-0.398	-0.280	-0.224
	(0.250)	(0.279)	(0.276)	(0.277)	(0.242)	(0.286)	(0.270)	(0.271)
At least one parent completed at least higher secondary education	0.905***	0.852***	0.793***	1.216***	0.245	0.356	0.235	0.242
[compared with student without parents (deceased or not living with the child) or parent/s had primary education or lower only]	(0.235)	(0.254)	(0.249)	(0.356)	(0.227)	(0.259)	(0.243)	(0.349)
At least one parent completed at least middle or lower secondary	0.098	0.157	0.124	0.144	-0.363	-0.496*	-0.357	-0.351
Compared with student without parents (deceased or not living with	(0.237)	(0.256)	(0.251)	(0.251)	(0, 230)	(0.262)	(0.246)	(0.246)
the child) or parent/s had primary education or lower only	(0.201)	(0.200)	(0.201)	(0.201)	(0.200)	(0.202)	(0.210)	(0.210)
Number of siblings	-0.084**	-0.066	-0.095**	-0.142*	0.022	0.068*	0.030	0.002
······································	(0.037)	(0.040)	(0.040)	(0.080)	(0.035)	(0.041)	(0.039)	(0.078)
School characteristics				· · · · ·				· · · · ·
School has boarding facilities		0.507**	2.058***	2.235***		1.813***	1.205**	1.678***
5		(0.205)	(0.464)	(0.578)		(0.209)	(0.474)	(0.582)
School is located in urban area		0.545***	2.167***	2.218***		0.338	1.710***	1.775***
		(0.198)	(0.334)	(0.334)		(0.205)	(0.328)	(0.329)
Class XII class size		0.078***	-0.039	-0.041		0.122***	0.110***	0.107***
		(0.022)	(0.036)	(0.036)		(0.022)	(0.035)	(0.035)
Number of Class XII English teachers		-0.039	-0.105	-0.156				
		(0.087)	(0.123)	(0.125)				
Number of Class XII Dzongkha teachers			-			0.561***	0.842***	0.792***
						(0.091)	(0.123)	(0.125)
Number of computers available to all students		0.004	0.018***	0.019***		-0.022***	-0.042***	-0.042***
		(0.003)	(0.004)	(0.004)		(0.003)	(0.004)	(0.004)

Variable		Class XII En	glish Score		Class XII Dzongkha Score				
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
Residential interaction with household characteristics									
School has boarding facilities × At least one parent completed at				-0.849*				-0.072	
least higher secondary education				(0.483)				(0.472)	
School has boarding facilities × Student has access to computer at				-0.463				-1.152***	
home				(0.391)				(0.382)	
School has boarding facilities × Number of siblings				0.060				0.035	
				(0.091)				(0.089)	
SCHOOL FIXED EFFECTS	YES	NO	NO	NO	YES	NO	NO	NO	
DISTRICT FIXED EFFECTS	NO	NO	YES	YES	NO	NO	YES	YES	
Constant	6.722***	3.097***	0.433	0.454	7.748***	-0.052	3.050**	2.841**	
	(0.831)	(1.002)	(1.266)	(1.294)	(0.786)	(1.048)	(1.232)	(1.256)	
Observations	5,451	4,792	4,792	4,792	5,448	4,789	4,789	4,789	
R-squared	0.700	0.667	0.684	0.684	0.739	0.674	0.716	0.717	

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

#### School Characteristics

Model 2 results show that students who attended schools with residential facilities achieved higher scores in Class XII English and Dzongkha exams compared with those who lived at home. Meanwhile, urban students generally performed better in English, as well as in Dzongkha, but only after accounting for district fixed effects. However, it is important to note that there is a drop in the number of observations owing to missing values in the number of Class X English teachers.

When it comes to school class size, the average class size in Class XII no longer predicts student performance in English exams after accounting for district fixed effects. On the other hand, a larger class size enhances Dzongkha scores. Additionally, students from schools with a high number of Dzongkha teachers had higher scores in the Dzongkha language subject. Meanwhile, number of English teachers is not a significant predictor of English scores.

The number of usable computers available to students at the school level has a significant impact on students' English examination performance. Interestingly, a higher average number of available computers for all students resulted in slightly lower scores in Dzongkha but had a positive correlation with English scores. This school input variable may be capturing an unknown indicator not included in our regression models, as access to a computer at home is not a significant predictor of Dzongkha examination scores. This is likely because of the underdevelopment of online Dzongkha learning materials.

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO) (2023), in 2018 20% of primary schools and 98% of secondary schools had at least one computer lab. However, the number of computers was insufficient, and student access to digital devices was limited to information and communication technology classes only. Norbu and Namgyel (2019) reported that technology for Dzongkha was limited to input, storage, and display, with no working Dzongkha language processing tools such as spelling or grammar checkers. Although operating systems like Windows, MacOS, iOS, and Android have built-in Dzongkha rendering and input support, there are no language packs or localized versions of operating systems available in Dzongkha, except for older versions of Linux. These challenges, combined with a lack of funds and expert personnel, have hindered Bhutan's progress in developing computer-compatible Dzongkha software and processors.

#### Residential School Interaction with Household Characteristics

Model 4 results indicate that attending a residential school attenuated the positive influence of having an educated parent at home (for English) and the positive influence of having a computer at home (for Dzongkha). By the same token, this suggests that

residential schools may have had a protective effect on learning for students who came from less privileged backgrounds.

#### B. Quantile Regression Analysis

Quantile regression analysis provides a more detailed perspective by showing how the influences of student and school determinants on performance vary for bottom (Q25), middle (Q50), and top Class X performers (Q75). Tables 4 and 5 display the results related to student, household, and current school characteristics for English and Dzongkha scores, respectively.

#### Student and Household Characteristics

The advantage for girls is most significant among lower-performing students and least significant among top performers for English scores. In the case of Dzongkha exam results, the differences between male and female students are observed only among bottom and middle performers.

Access to a computer at home affects the English exam results mainly of the lowperforming group except when residential interaction terms are introduced. On the other hand, access to a mobile phone significantly affects English scores only of the topperforming group when different school characteristics are taken into consideration. Similarly, the impact on Dzongkha exams of having a computer at home affected students only when residential interaction terms are considered, specifically those at the bottom and middle percentile groups. Meanwhile, having a mobile phone at home also affects Dzongkha performance across the four models but the results are mixed across percentile distributions. It affects bottom and top performers the most after accounting for different school characteristics (Model 2), and middle performers the most when districtlevel fixed effects (Model 3) are considered.

Meanwhile, having an educated parent at home significantly improved the scores of students in the middle and top English exam performers. However, Dzongkha scores of students with parents who completed at least middle or lower secondary education are lower, but this effect dissipates when district fixed effects are introduced.

#### School Characteristics

When we consider district-level fixed effects, students from schools with boarding facilities perform better in English national examinations regardless of their performance level. However, this effect diminishes when we account for different school characteristics. In contrast with for English results, when we account for different school characteristics, students from schools with boarding facilities perform better in Dzongkha examinations regardless of their performance level, but this affects only middle and top performers when district effects and interaction terms are accounted for.

The scores of top English and Dzongkha performers benefit from schools being located in urban areas when different school characteristics are accounted for, but there are no district fixed effects included. Meanwhile, all students in schools located in urban areas, regardless of performance level, have better English and Dzongkha scores when districtlevel fixed effects and interaction terms are considered.

The effect of current average class size on Class XII English exam performance is no longer significant when including district fixed effects. Surprisingly, students across all percentile groups from schools with a larger average class size perform better on Dzongkha examination when different school characteristics are accounted for. It remains significant only for those in the lower percentile group when district effects are considered.

As expected, a higher number of Dzongkha teachers led to improved Dzongkha performance across all percentile groups. This trend is not observed for English performance. On the other hand, students from schools with a higher number of usable computers for students perform better in English exams regardless of their performance level when accounting for district fixed effects. Meanwhile, in line with the findings of the DOLS regression for Dzongkha scores, students from schools with a higher number of usable computers had lower exam scores, regardless of the exam results' percentile group. It is unknown whether this variable captures a different school input that negatively affects Dzongkha performance, or if the prevalence of English language software on computers drives the outcome.

### Table 4: Quantile Regression Results for English Exam Scores

		Model 1 Model 2 Model 3						Model 4				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variable	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75
Dependent variable: Class XII test scores	37.44	46.38	53.66	37.60	46.40	53.69	37.60	46.40	53.69	37.60	46.40	53.69
Student and household characteristics												
Class X English score	0.925*** (0.009)	0.913*** (0.012)	0.907*** (0.011)	0.935*** (0.013)	0.935*** (0.015)	0.913*** (0.014)	0.935*** (0.012)	0.919*** (0.012)	0.909*** (0.011)	0.935*** (0.015)	0.923*** (0.014)	0.910*** (0.014)
Student is male	-0.886*** (0.201)	-0.685*** (0.215)	-0.596** (0.242)	-0.978*** (0.278)	-0.715*** (0.173)	-0.672*** (0.196)	-0.866*** (0.161)	-0.907*** (0.231)	-0.644*** (0.169)	-0.807*** (0.287)	-0.830*** (0.307)	-0.662*** (0.247)
Student has access to computer at home	0.728*** (0.240)	0.509** (0.209)	0.545** (0.226)	0.818*** (0.214)	0.432** (0.215)	0.808*** (0.193)	0.664*** (0.225)	0.466*** (0.156)	0.519** (0.265)	1.006* (0.548)	0.661 (0.469)	1.048*** (0.391)
Student has access to mobile phone at home	0.298 (0.759)	0.802 (0.704)	1.219* (0.681)	0.476 (0.667)	0.563 (0.731)	1.508** (0.586)	0.802 (0.877)	1.225 (0.814)	1.236 (0.946)	0.626 (0.597)	1.243 (0.788)	1.315 (1.082)
Student has access to television at home	0.290 (0.353)	0.304 (0.397)	0.210 (0.252)	0.055 (0.364)	0.373 (0.295)	-0.162 (0.403)	0.201 (0.413)	0.179 (0.358)	0.189 (0.365)	0.234 (0.326)	0.103 (0.328)	0.174 (0.331)
At least one parent completed at least higher secondary education [compared with student without parents (deceased or not living with the child) or parent/s had primary education or lower only]	0.541 (0.349)	1.016*** (0.247)	1.192*** (0.330)	0.673** (0.335)	0.968** (0.401)	1.400*** (0.361)	0.478 (0.390)	1.130*** (0.380)	1.187*** (0.358)	0.867** (0.417)	1.448*** (0.354)	1.450*** (0.420)
At least one parent completed at least middle or lower secondary education [compared with student without parents (deceased or not living with the child) or parent/s had primary education or lower only]	0.033 (0.313)	0.380 (0.292)	0.265 (0.207)	-0.201 (0.479)	0.342 (0.355)	0.293 (0.378)	0.052 (0.432)	0.489 (0.357)	0.350 (0.286)	0.008 (0.557)	0.491 (0.356)	0.270 (0.267)
Number of siblings	-0.064 (0.052)	-0.070 (0.055)	-0.074 (0.063)	-0.021 (0.071)	-0.047 (0.048)	0.001 (0.061)	-0.048 (0.063)	-0.070 (0.049)	-0.068 (0.056)	-0.196 (0.150)	-0.084 (0.129)	-0.029 (0.110)
School characteristics												
School has boarding facilities				0.220 (0.292)	0.146 (0.210)	0.504* (0.259)	1.837*** (0.646)	2.037** (0.815)	1.960*** (0.644)	1.653** (0.783)	2.119** (0.922)	2.361*** (0.792)
School is located in urban area				0.423 (0.378)	0.484 (0.314)	0.603*** (0.223)	2.365*** (0.490)	2.341*** (0.572)	2.334*** (0.572)	2.452*** (0.432)	2.360*** (0.470)	2.339*** (0.402)
Class XII class size				0.116*** (0.041)	0.058*** (0.022)	0.083*** (0.022)	-0.016 (0.036)	-0.044 (0.062)	-0.044 (0.041)	-0.026 (0.049)	-0.041 (0.051)	-0.045 (0.070)
Number of Class XII English teachers				-0.109 (0.127)	-0.006 (0.108)	0.031 (0.128)	-0.128 (0. 183)	-0.260 (0.163)	-0.064 (0.154)	-0.170 (0.185)	-0.325* (0.178)	-0.147 (0.172)

		Model 1			Model 2			Model 3			Model 4	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variable	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75
Number of computers available to all students				0.011* (0.007)	0.006 (0.004)	0.003 (0.003)	0.020*** (0.006)	0.022*** (0.004)	0.018*** (0.003)	0.019*** (0.006)	0.022*** (0.006)	0.020*** (0.005)
Residential interaction with household	characterist	ics										
School has boarding facilities × At least one parent completed at least higher secondary education										-0.765 (0.553)	-0.513 (0.678)	-0.583 (0.556)
School has boarding facilities × Student has access to computer at home										-0.268 (0.465)	-0.322 (0.449)	-0.714 (0.483)
School has boarding facilities × Number of siblings										0.192 (0.147)	0.026 (0.131)	-0.052 (0.118)
SCHOOL FIXED EFFECTS	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO
DISTRICT FIXED EFFECTS	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES
Constant	2.799*** (0.910)	6.225*** (1.051)	9.861*** (1.485)	-2.318 (1.691)	3.045** (1.242)	5.910*** (0.994)	-5.257*** (2.007)	-0.479 (1.755)	4.191*** (1.536)	-4.569** (1.970)	-0.417 (1.793)	3.371* (1.752)
Observations	5,451	5,451	5,451	4,792	4,792	4,792	4,792	4,792	4,792	4,792	4,792	4,792
pR2q1	0.457	0.457	0.457	0.422	0.422	0.422	0.4411	0.4411	0.4411	0.442	0.442	0.442
pR2q2	0.476	0.476	0.476	0.446	0.446	0.446	0.4618	0.4618	0.4618	0.462	0.462	0.462
pR2q3	0.472	0.472	0.472	0.443	0.443	0.443	0.4572	0.4572	0.4572	0.458	0.458	0.458

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

### Table 5: Quantile Regression Results for Dzongkha Exam Scores

	Model 1				Model 2			Model 3			Model 4	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variable	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75
Dependent variable: Class XII test scores	37.76	48.14	55.30	37.74	47.54	54.23	37.74	47.54	54.23	37.74	47.54	54.23
Student and household characteristics												
Class X Dzongkha score	0.893*** (0.012)	0.877*** (0.011)	0.843*** (0.011)	0.939*** (0.015)	0.925*** (0.011)	0.882*** (0.009)	0.895*** (0.017)	0.887*** (0.013)	0.856*** (0.011)	0.900*** (0.014)	0.884*** (0.011)	0.857*** (0.011)
Student is male	-0.920*** (0.202)	-0.597*** (0.180)	-0.231 (0.220)	-0.964*** (0.238)	-0.613*** (0.186)	-0.289 (0.209)	-0.811*** (0.201)	-0.601** (0.235)	-0.292 (0.200)	-0.878*** (0.228)	-0.617*** (0.158)	-0.310 (0.201)
Student has access to computer at home	0.103 (0.289)	0.222 (0.219)	0.413* (0.229)	0.038 (0.263)	0.342 (0.217)	0.272 (0.221)	0.324 (0.232)	0.287 (0.229)	0.380 (0.292)	1.183*** (0.327)	0.997** (0.408)	0.742* (0.432)
Student has access to mobile phone at home	0.709 (0.769)	1.036** (0.432)	1.025 (0.746)	1.770*** (0.513)	0.360 (0.787)	1.928*** (0.511)	1.262 (1.207)	1.567*** (0.414)	1.344** (0.673)	1.428 (1.359)	1.613*** (0.569)	1.333** (0.630)
Student has access to television at home	-0.031 (0.326)	-0.446 (0.290)	-0.258 (0.335)	-0.580* (0.332)	-0.459 (0.401)	-0.556 (0.420)	-0.399 (0.474)	-0.641* (0.333)	-0.354 (0.357)	-0.336 (0.467)	-0.691* (0.368)	-0.300 (0.330)
At least one parent completed at least higher secondary education [compared with student without parents (deceased or not living with the child) or parent/s had primary education or lower only]	0.281 (0.456)	0.196 (0.341)	0.212 (0.300)	0.425 (0.388)	0.375 (0.319)	0.095 (0.321)	0.304 (0.417)	0.323 (0.253)	0.324 (0.256)	0.417 (0.435)	-0.152 (0.446)	0.590 (0.383)
At least one parent completed at least middle or lower secondary education [compared with student without parents (deceased or not living with the child) or parent/s had primary education or lower only]	-0.416 (0.313)	-0.289 (0.240)	-0.471** (0.231)	-0.538* (0.323)	-0.617*** (0.234)	-0.790* (0.426)	-0.184 (0.325)	-0.334 (0.362)	-0.257 (0.325)	-0.137 (0.351)	-0.353* (0.206)	-0.233 (0.293)
Number of siblings	0.050 (0.039)	0.019 (0.046)	0.015 (0.044)	0.056 (0.059)	0.064 (0.050)	0.036 (0.038)	-0.016 (0.042)	0.031 (0.040)	0.047 (0.071)	-0.050 (0.123)	0.085 (0.101)	0.115 (0.103)
School characteristics												
School has boarding facilities				1.653*** (0.436)	1.624*** (0.273)	1.619*** (0.244)	-0.101 (0.600)	1.575** (0.697)	1.452** (0.736)	0.729 (1.160)	2.332*** (0.612)	2.284*** (0.840)
School is located in urban area				0.018 (0.312)	0.160 (0.284)	0.832*** (0.316)	1.626*** (0.438)	1.839*** (0.512)	2.159*** (0.479)	1.676*** (0.567)	1.835*** (0.446)	2.299*** (0.535)
Class XII class size				0.102*** (0.029)	0.090*** (0.028)	0.115*** (0.031)	0.190** (0.074)	0.029 (0.060)	0.061 (0.047)	0.164*** (0.062)	0.013 (0.047)	0.040 (0.059)
Number of Class XII Dzongkha teachers				0.627*** (0.117)	0.590*** (0.098)	0.599*** (0.099)	0.961*** (0.142)	0.861*** (0.189)	0.777*** (0.081)	0.878*** (0.176)	0.837*** (0.170)	0.799*** (0.162)

Continued on the next page

		Model 1			Model 2			Model 3			Model 4	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variable	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75
Number of computers available to all students				-0.014***	-0.020***	-0.035***	-0.050***	-0.037***	-0.042***	-0.044***	-0.037***	-0.041***
Residential interaction with household charac	teristics			(0.004)	(0.000)	(0.000)	(0.007)	(0.004)	(0.000)	(0.007)	(0.000)	(0.000)
School has boarding facilities × At least one parent completed at least higher secondary education										-0.072 (0.692)	0.809 (0.650)	-0.410 (0.636)
School has boarding facilities × Student has access to computer at home										-1.264*** (0.475)	-1.069** (0.525)	-0.573 (0.560)
School has boarding facilities × Number of siblings										0.046 (0.118)	-0.062 (0.100)	-0.094 (0.117)
SCHOOL FIXED EFFECTS	YES	YES	YES	NO	NO	NO						
DISTRICT FIXED EFFECTS	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES
Constant	2.589**	7.187***	11.638***	-5.468***	0.818	5.335***	1.557	3.299**	7.158***	-2.420	3.644*	6.817***
	(1.289)	(1.134)	(1.052)	(1.059)	(1.318)	(1.152)	(2.289)	(1.477)	(1.487)	(1.644)	(1.883)	(1.772)
Observations	5,448	5,448	5,448	4,789	4,789	4,789	4,789	4,789	4,789	4,789	4,789	4,789
pR2q1	0.503	0.503	0.503	0.443	0.443	0.443	0.4801	0.4801	0.4801	0.481	0.481	0.481
pR2q2	0.505	0.505	0.505	0.443	0.443	0.443	0.48	0.48	0.48	0.481	0.481	0.481
pR2q3	0.498	0.498	0.498	0.432	0.432	0.432	0.4725	0.4725	0.4725	0.473	0.473	0.473

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

#### Residential Interaction with Household Characteristics

The interaction effects observed for simple linear regression hold for quantile regression and appear to be stronger for low-performing students, although for English the results are no longer statistically significant owing to the smaller size of the sample.

Generally, the patterns suggest that computer access especially helps lower-performing students in English, whereas parental education helps higher-performing students. Interestingly, the parental education effect persists for high-performing students even if they are in boarding schools. For Dzongkha, patterns are less clear across the distribution.

#### VI. ADDITIONAL ROBUSTNESS CHECKS

In our data, most students attend up to the highest level offered by their school (middle secondary schools offer up to Class X, upper secondary schools offer up to Class XII) before switching schools. We found that our results are robust to different approaches, such as excluding voluntary school switchers, regressing outcomes on students' original school characteristics, and regressing outcomes on students' final school characteristics.

#### A. School Characteristics in Both Class X and Class XII

Regressions controlling for school inputs in both Class X and Class XII (Appendix Tables A1–A3) allow us to examine the impact of characteristics of schools previously attended, taking into account the school inputs available to students before the pandemic. However, accounting for Class X school inputs lowers the number of observations thus is not used as one of the main specifications. Patterns are similar to in the main findings, except for the changes described below.

Parental education becomes a significant predictor of Dzongkha scores when considering school characteristics (Model 2) and district fixed effects with interaction terms (Model 3). Impact of class size on Dzongkha performance diminishes with the introduction of district fixed effects and interaction terms. Conversely, number of Class XII subject teachers becomes significant for English performance, and availability of computers at school becomes significant for English scores when using actual school characteristics.

Furthermore, our quantile regression reveals that the advantage of girls becomes most significant for middle performers in English scores when controlling for school fixed effects. Home access to computer becomes significant to Dzongkha for middle performers when accounting for school characteristics, as well as across the percentile distribution when considering for district effects and interaction terms.

Parental education becomes significant for bottom English performers when considering school fixed effects but loses significance when accounting for school characteristics as well as district fixed effects and interaction terms. Residential schools have more pronounced benefits for top English performers and middle Dzongkha performers. Students in urban schools, regardless of performance level, have higher English scores. For Dzongkha, bottom performers in urban schools have lower Dzongkha scores only when accounting for school characteristics but have higher Dzongkha scores when considering district fixed effects and interaction terms.

The effect of class size on English scores is not significant for middle performers, and the effect of computer availability at school on English scores becomes significant across the percentile distribution when school characteristics are factored in. Number of Class XII subject teachers does not affect bottom Dzongkha performers. On the other hand, when considering district fixed effects and interaction terms, number of Class XII subject teachers impacts English students across quintiles and impacts only bottom English performers when considering school fixed effects.

#### B. Excluding Voluntary Switchers

We conduct regressions excluding students who switched schools voluntarily (see Appendix Tables B1–B3). This is done to maintain a focus on students who stayed in the same school from Class X to Class XII or those who attended schools in Class X that did not offer education up to Class XII. This approach allows us to consider potential disparities in school quality between the two classes. When we exclude voluntary switchers, regression samples drop by 24%. The trends in the main findings for predictors, such as past performance, sex, class size, and number of subject teachers, remain the same. However, there are some changes in the significance of certain variables when compared with the main findings. For instance, access to a computer and mobile phone at home, parental education (completed at least higher secondary education), number of siblings, attending a residential school, attending a school in an urban area, and having access to usable computers remained significant but with changes across different models and student distributions.

When we consider school fixed effects, access to a computer at home becomes significant for middle and top Dzongkha performers. On the other hand, home access to a mobile phone is no longer significant for bottom Dzongkha performers when accounting for school characteristics, and for middle Dzongkha performers when considering district fixed effects and interaction terms. Additionally, parental education (completed at least higher secondary education) no longer affects bottom English performers when considering school characteristics as well as district effects with interaction terms. Number of siblings becomes significant when considering district fixed effects and attending a residential school or a school in an urban area no longer

affects English performance when school characteristics are considered. We also observe that presence of usable computers becomes significant for English scores, affecting bottom and middle English performers.

#### VII. CONCLUSIONS

This analysis has compared the exam performance gaps of Bhutanese secondary school students before and after school closures under COVID-19 and identified the determinants of exam performance. The data do not allow for strong conclusions to be drawn on absolute learning, but performance gaps that existed between student groups prior to closures in 2019 (notably with respect to parents' education and computer ownership) did not widen substantially after closures in 2021. Only the English subject advantage of girls and urban students increased slightly.

The results of the linear regression and quantile regression analyses indicate several significant predictors of learning achievement. These predictors include sex (with male students performing worse than female students), access to technology at home, parental education, schools with boarding facilities, schools in urban areas, class size, and availability of usable computers to students.

Moreover, the inclusion of district effects and interaction terms shows that a higher number of computers available to all students significantly affected students' examination performance in English but not in Dzongkha. Access to technology at home, such as computers and mobile phones, also played a role. For example, home access to a computer benefited students in lower grades for English but affected middle and top Dzongkha performers only when district fixed effects and interaction terms are considered. Having an educated parent (completed at least higher secondary education) significantly improved English scores of students in the middle and top performers. The results on computer ownership suggest that educational technology has the potential to improve learning outcomes for English but that effects on Dzongkha are likely more limited owing to less Dzongkha language teaching content being available online.

Perhaps the clearest result from the regression analysis is the importance of a stable learning environment during disruptions. Students from disadvantaged households who boarded at their schools during the pandemic were less likely to fall behind.

According to a report by the United Nations Children's Fund (UNICEF) and UNESCO in 2021, Bhutan's response to the pandemic was comprehensive. The country utilized its existing structures and data to quickly inform, plan, and implement initiatives to mitigate the learning losses caused by school closures. The focus of the response was on supporting remote learning and reaching as many students as possible. The government developed an adapted curriculum for scenarios of continued school closure and prioritized

a curriculum that anticipated the reopening of schools. Remote or home-based learning using the adapted curriculum was promptly delivered through various means and platforms, such as video lessons, radio programs, self-learning printed materials, and interactive support from teachers. Students in Class IX to Class XII, who were due to take high-stakes exams, were given priority, with more online lessons and broadcast hours devoted to them. They were also the first classes to return to school. Additionally, students living in high-risk areas were moved to boarding schools in less risky areas to ensure continuity of their education (Ministry of Education and Skills Development, Helvetas Bhutan, and UNICEF 2021). Limited learning losses found in this study suggest that the approach of limited closure and focused support during closure was effective.

This study focuses on an important aspect of education and complements research on the health outcomes of Bhutan's response to the COVID-19 pandemic. Additional areas for possible research include using administrative data to identify significant changes in school participation (dropout) during school closures (Pokhrel and Chhetri 2021). Another area of potential future research concerns outcomes for cohorts of students who were younger during the closures. Given the prioritization of upper secondary education, the impact of closures on learning outcomes for students taking the BCSE and BHSEC during COVID-19 pandemic was seemingly limited. However, younger students who experienced longer closures may continue to feel the effects of the closure throughout their academic lives. This is particularly true because some studies indicate that younger students were more severely affected by closures owing to their lower preparedness for self-guided learning (Zierer 2021).

Finally, the findings of this study have clear policy implications. The negligible effect of computer access on Dzongkha performance suggests there is room to improve online materials for Dzongkha instruction and highlights the need for capacity building and budget allocation for the development of Dzongkha-compatible computer technologies. Additionally, the substantial positive effects of boarding facilities and their ability to cancel out effects of household wealth and assets suggest that they can play an important role in equalizing student access to education and educational resilience.

#### APPENDIX

## Table A1: Linear Regression Results for English and Dzongkha Exam Scores with Both Class Xand Class XII School Inputs and Characteristics

Variable	Clas	s XII English	Score	Class )	(II Dzongki	na Score
	(1)	(2)	(3)	(1)	(2)	(3)
Student and household characteristics						
Class X English score	0.930***	0.919***	0.917***			
	(0.011)	(0.012)	(0.012)			
Class X Dzongkha score				0.870***	0.892***	0.859***
				(0.009)	(0.011)	(0.011)
Student is male	-0.791***	-0.959***	-0.978***	-0.721***	-0.762***	-0.665***
	(0.148)	(0.183)	(0.180)	(0.142)	(0.190)	(0.178)
Student has access to computer at home	0.699***	1.028***	1.080***	0.186	0.313	1.300***
	(0.174)	(0.212)	(0.380)	(0.165)	(0.215)	(0.373)
Student has access to mobile phone at home	0.585	0.713	0.636	0.842	1.179*	1.240**
	(0.538)	(0.642)	(0.629)	(0.513)	(0.662)	(0.619)
Student has access to television at home	0.283	-0.019	0.003	-0.170	-0.269	-0.303
	(0.248)	(0.308)	(0.305)	(0.237)	(0.318)	(0.301)
At least one parent completed at least higher secondary	0.937***	0.822***	1.206***	0.373*	0.140	-0.207
education [compared with student without parents	(0.234)	(0.277)	(0.396)	(0.224)	(0.285)	(0.391)
(deceased or not living with the child) or parent/s had						
primary education or lower only	0.407	0.404	0 474	0.040	0.070**	0.470*
At least one parent completed at least middle or lower	0.187	0.161	0.174	-0.248	-0.670^^	-0.478^
secondary education [compared with student without	(0.235)	(0.288)	(0.283)	(0.225)	(0.297)	(0.279)
parents (deceased or not living with the child) or						
parent/s had primary education or lower only	0.074*	0.040	0 407**	0.000	0.050	0.047
Number of sidlings	-0.071*	-0.043	-0.187**	0.026	0.053	-0.017
Och cel cherrestariation	(0.036)	(0.045)	(0.094)	(0.035)	(0.046)	(0.092)
		0 540*	4 050**		0.4.40	0.000
Class X student in school with boarding facilities		-0.518*	-1.252**		0.149	-0.362
Olean VII student in school with hearding facilities		(0.289)	(0.631)		(0.323)	(0.637)
Class XII student in school with boarding facilities		1.144****	3.033		1.429****	2.707
Class X student in school lossted in urban area		(0.338)	(0.801)		(0.354)	(0.814)
		0.010			-0.340	
Class XII student in school located in urban area		(U.240) 1 152***	(U.202) 2 700***		(0.208)	(U.∠oo) 2 202***
		(0.274)	2.199		(0.100)	2.203
		(0.274)	(0.407)		(0.295)	(0.411)

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Variable	Clas	s XII English	Score	Class X	(II Dzongkh	a Score
	(1)	(2)	(3)	(1)	(2)	(3)
Class X class size		0.009***	0.009***		-0.003	0.006*
		(0.003)	(0.003)		(0.002)	(0.003)
Class XII class size		0.075***	-0.037		0.136***	0.073*
		(0.026)	(0.040)		(0.027)	(0.040)
Number of Class X English teachers		-0.184	-0.217			
		(0.169)	(0.197)			
Number of Class XII English teachers		-0.208**	-0.546***			
		(0.104)	(0.173)			
Number of Class X Dzongkha teachers					-0.391***	-0.372***
					(0.087)	(0.088)
Number of Class XII Dzongkha teachers					0.489***	0.352**
					(0.109)	(0.153)
Number of computers available to Class X students		-0.022***	-0.019***		0.000	-0.002
		(0.005)	(0.005)		(0.005)	(0.005)
Number of computers available to Class XII students		0.015***	0.020***		-0.024***	-0.054***
		(0.005)	(0.006)		(0.005)	(0.006)
Residential interaction with household characteristics						
Class X student in school with boarding facilities × At least one parent			1.838**			0.317
completed at least higher secondary education			(0.807)			(0.795)
Class XII student in school with boarding facilities × At least one parent			-2.359***			0.092
completed at least higher secondary education			(0.806)			(0.794)
Class X student in school with boarding facilities × Student has access	to		0.702			0.398
computer at home			(0.563)			(0.554)
Class XII student in school with boarding facilities × Student has access	s to		-0.962			-1.799***
computer at home			(0.598)			(0.589)
Class X student in school with boarding facilities × Number of siblings			0.076			0.044
			(0.128)			(0.126)
Class XII student in school with boarding facilities × Number of siblings			0.041			0.013
			(0.140)			(0.138)
SCHOOL FIXED EFFECTS	YES	NO	NO	YES	NO	NO
DISTRICT FIXED EFFECTS	NO	NO	YES	NO	NO	YES
Constant	4.976***	3.216***	2.224	6.156***	1.717	6.323***
	(1.057)	(1.118)	(1.539)	(0.998)	(1.189)	(1.447)
Observations	5,451	3,770	3,770	5,448	3,767	3,767
R-squared	0.720	0.680	0.701	0.763	0.676	0.723

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## Table A2: Quantile Regression Results for English Exam Scores with Both Class Xand Class XII School Inputs and Characteristics

		Model 1			Model 2			Model 3	
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75
Student and household characteristics									
Class X English score	0.960***	0.933***	0.917***	0.943***	0.940***	0.906***	0.947***	0.941***	0.917***
	(0.010)	(0.014)	(0.019)	(0.015)	(0.014)	(0.020)	(0.017)	(0.021)	(0.017)
Student is male	-0.659***	-0.769***	-0.520**	-1.121***	-0.836***	-0.754***	-0.798***	-1.022***	-1.014***
	(0.195)	(0.193)	(0.213)	(0.286)	(0.173)	(0.214)	(0.228)	(0.228)	(0.203)
Student has access to computer at home	0.631***	0.510**	0.663***	1.146***	0.721**	1.113***	0.908*	0.735*	0.948**
	(0.203)	(0.221)	(0.250)	(0.309)	(0.303)	(0.294)	(0.501)	(0.434)	(0.482)
Student has access to mobile phone at home	0.237	0.832	1.248	0.803	0.922	1.687**	0.565	1.645	0.920
0.1.1.	(0.732)	(0.688)	(0.764)	(0.502)	(0.835)	(0.679)	(0.788)	(1.013)	(1.165)
Student has access to television at nome	0.368	0.262	0.227	-0.425	0.022	-0.450	0.058	-0.207	-0.489
At least one want concluted at least birty	(0.294)	(0.411)	(0.339)	(0.455)	(0.426)	(0.382)	(0.381)	(0.400)	(0.312)
At least one parent completed at least nigher	0.906	0.981	1.153***	0.635"	0.963**	1.359	1.007	1.547	1.415***
secondary education [compared with student without	(0.348)	(0.371)	(0.383)	(0.355)	(0.457)	(0.406)	(0.616)	(0.437)	(0.409)
parents (deceased or not living with the child) or									
At least one percent completed at least middle or lower	0 157	0 500*	0.166	0.220	0.206	0.442	0 1 1 2	0.407	0 509
At least one parent completed at least middle of lower	-0.157	0.302	0.100	-0.330	0.200	0.443	0.112	0.407	0.300
parents (deceased or pet living with the child) or	(0.323)	(0.200)	(0.294)	(0.391)	(0.350)	(0.375)	(0.463)	(0.406)	(0.301)
parents (deceased of hot living with the child) of									
Number of siblings	-0.038	-0.064	-0.003*	-0.038	0 022	0.031	-0.285**	_0 108*	-0.063
Number of splings	-0.038	-0.004	-0.093	-0.038	-0.022	(0.051)	-0.203	-0.190	-0.003
School characteristics	(0.000)	(0.001)	(0.0+3)	(0.031)	(0.007)	(0.000)	(0.150)	(0.112)	(0.101)
Class X student in school with boarding facilities				0.005	0 704	0.602	1 571	0.740	1 002***
Class A student in school with boarding facilities				(0.336)	-0.794	-0.092	(1 121)	-0.749 (1.035)	-1.902
Class XII student in school with boarding facilities				0.706	1 177**	1 2/0**	3 383**	2 97/***	3 / 29***
Class XII student in school with boarding facilities				(0.560)	(0.582)	(0.606)	(1 326)	(1 052)	(1 0 4 4)
Class X student in school located in urban area				0.223	0.137	0.327	-0.156	0 122	-0.012
				(0.417)	(0.364)	(0.313)	(0.453)	(0.375)	(0.360)
Class XII student in school located in urban area				1 257***	1 053**	1 127***	3 128***	3 186***	2 847***
				(0.377)	(0.431)	(0.435)	(0 784)	(0.716)	(0.666)
Class X class size				0.014***	0.009***	0.007*	0.012**	0.009**	0.009**
				(0.003)	(0.003)	(0.004)	(0.005)	(0.004)	(0.004)
Class XII class size				0.086**	0.052	0.092***	-0.041	-0.049	-0.012
				(0.035)	(0.033)	(0.034)	(0.072)	(0.068)	(0.057)
Number of Class X English teachers				-0.668***	-0.125	-0.246	-0.381	-0.218	-0.205
6				(0.221)	(0.216)	(0.259)	(0.304)	(0.265)	(0.250)
Number of Class XII English teachers				-Ò.316***	-0.203	-0.188	-0.703**	-0.874***	-0.494**
				(0.119)	(0.129)	(0.176)	(0.280)	(0.177)	(0.226)

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		Model 1			Model 2			Model 3	
Variable	(1) Q25	(2) Q50	(3) Q75	(4) Q25	(5) Q50	(6) Q75	(7) Q25	(8) Q50	(9) Q75
Number of computers available to Class X students				-0.022***	-0.031***	-0.017***	-0.018**	-0.025***	-0.018***
				(0.008)	(0.007)	(0.005)	(0.009)	(0.006)	(0.006)
Number of computers available to Class XII students				0.018**	0.025***	0.011**	0.028***	0.023***	0.022***
				(0.009)	(0.007)	(0.006)	(0.009)	(0.008)	(0.007)
Residential interaction with household characteristic	cs								
Class X student in school with boarding facilities ×							2.665***	1.963*	2.262
At least one parent completed at least higher							(1.026)	(1.036)	(1.565)
secondary education									
Class XII student in school with boarding facilities ×							-3.286***	-3.076***	-2.735*
At least one parent completed at least higher secondary education							(1.145)	(0.945)	(1.510)
Class X student in school with boarding facilities ×							0.287	0.802	1.369
Student has access to computer at home							(0.894)	(0.841)	(1.043)
Class XII student in school with boarding facilities ×							-0.572	-0.658	-1.595*
Student has access to computer at home							(0.914)	(0.853)	(0.903)
Class X student in school with boarding facilities ×							0.180	-0.020	0.059
Number of siblings							(0.238)	(0.182)	(0.183)
Class XII student in school with boarding facilities ×							0.095	0.116	-0.051
Number of siblings							(0.240)	(0.211)	(0.203)
SCHOOL FIXED EFFECTS	YES	YES	YES	NO	NO	NO	NO	NO	NO
DISTRICT FIXED EFFECTS	NO	NO	NO	NO	NO	NO	YES	YES	YES
Constant	0.378	5.259***	8.046***	-1.305	2.650**	6.145***	-3.842*	1.267	5.114**
Observations	(1.477)	(1.364)	(2.020)	(1.562)	(1.060)	(1.392)	(2.305)	(2.467)	(2.213)
Observations	5,451	5,451	5,451	3,770	3,770	3,770	3,770	3,770	3,770
	0.483	0.483	0.483	0.439	0.439	0.439	0.464	0.464	0.464
przqz	0.498	0.498	0.498	0.460	0.460	0.460	0.481	0.481	0.481
pR2q3	0.494	0.494	0.494	0.452	0.452	0.452	0.472	0.472	0.472

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## Table A3: Quantile Regression Results for Dzongkha Exam Scores with Both Class X and Class XII School Inputs and Characteristics

		Model 1			Model 2			Model 3	1
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75
Student and household characteristics									
Class X Dzongkha score	0.900***	0.894***	0.852***	0.921***	0.913***	0.875***	0.888***	0.874***	0.842***
	(0.014)	(0.013)	(0.014)	(0.019)	(0.013)	(0.010)	(0.020)	(0.016)	(0.014)
Student is male	-0.945***	-0.643***	-0.227	-1.230***	-0.724***	-0.331*	-0.880***	-0.608***	-0.199
	(0.160)	(0.199)	(0.182)	(0.191)	(0.184)	(0.183)	(0.334)	(0.224)	(0.280)
Student has access to computer at home	-0.037	0.267	0.386	0.282	0.562***	0.374	1.754***	1.257***	0.925**
	(0.208)	(0.270)	(0.301)	(0.310)	(0.218)	(0.314)	(0.467)	(0.477)	(0.417)
Student has access to mobile phone at home	0.334	1.058*	0.931	1.681	0.293	1.552***	1.238*	1.470**	0.541
	(0.623)	(0.543)	(0.667)	(1.251)	(0.856)	(0.500)	(0.682)	(0.618)	(0.730)
Student has access to television at home	-0.332	-0.229	-0.059	-0.268	-0.464	-0.547*	-0.333	-0.624**	-0.461
••• •	(0.298)	(0.272)	(0.328)	(0.614)	(0.380)	(0.328)	(0.347)	(0.306)	(0.476)
At least one parent completed at least higher secondary	0.541*	0.514*	0.351	0.303	0.240	-0.026	-0.608	-0.545	-0.100
education [compared with student without parents	(0.300)	(0.281)	(0.304)	(0.620)	(0.371)	(0.377)	(0.497)	(0.526)	(0.574)
(deceased or not living with the child) or parent/s had									
primary education or lower only]	0.057	0.004	0.005	0 745	0.000**	0.000*	0.000	0.007	0.000
At least one parent completed at least middle or lower	-0.057	-0.224	-0.325	-0.715	-0.886""	-0.860"	-0.299	-0.297	-0.360
secondary education [compared with student without	(0.425)	(0.288)	(0.246)	(0.510)	(0.364)	(0.473)	(0.318)	(0.431)	(0.370)
bad primary advection or lower and									
Number of ciblings	0.024	0.042	0.017	0.074	0.051	0.004	0.029	0.020	0.022
	0.034	0.043	0.017	0.074	0.051	0.004	0.030	0.030	0.033
School characteristics	(0.044)	(0.052)	(0.030)	(0.074)	(0.003)	(0.002)	(0.130)	(0.120)	(0.094)
Close X student in school with boarding facilities				0.440	0 1 1 5	0.055	0.02	0 226	0.019
				0.440	-0.145	-0.055	(0.958)	(0 712)	-0.016
Class XII student in school with boarding facilities				0.615	1 356***	1 357***	(0.050)	2 852**	2 22/*
Class An student in school with boarding facilities				(0.572)	(0.470)	(0.434)	(1 178)	(1 315)	(1 210)
Class X student in school located in urban area				-0.220	-0 390	-0 366	0.001	-0.319	0.132
				(0.338)	(0.312)	(0.332)	(0.459)	(0.299)	(0.466)
Class XII student in school located in urban area				-0.798**	-0.117	0.803**	1.858***	2.162***	2.573***
				(0.366)	(0.470)	(0.390)	(0.662)	(0.799)	(0.743)
Class X class size				-0.004*	-0.004	-0.005	0.009**	0.002	0.003
				(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.004)
Class XII class size				0.141***	0.107***	0.121***	0.117**	0.012	0.053
				(0.036)	(0.023)	(0.034)	(0.050)	(0.078)	(0.060)
Number of Class X Dzongkha teachers				-0.399***	-0.360***	-0.325**	-0.359***	-0.365***	-0.378***
-				(0.129)	(0.098)	(0.136)	(0.127)	(0.123)	(0.109)
Number of Class XII Dzongkha teachers				0.654***	0.590***	0.484***	0.373*	0.523***	0.308**
				(0.160)	(0.142)	(0.119)	(0.221)	(0.180)	(0.155)

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		Model 1			Model 2		Model 3			
Variable	(1) 025	(2) 050	(3) 075	(4) 025	(5) 050	(6) 075	(7) 025	(8) 050	(9) 075	
Number of computers available to Class X students	QLU	400	QIU	-0.001	0.002	0.000	0.010	0.001	-0.009	
				(0.009)	(0.005)	(0.005)	(0.008)	(0.008)	(0.008)	
Number of computers available to Class XII students				-0.018**	-0.021***	-0.037***	-0.065***	-0.053***	-0.047***	
·				(0.008)	(0.005)	(0.005)	(0.010)	(0.009)	(0.011)	
Residential interaction with household characteristics					· · · ·	· · · · ·	· · · ·	· · ·	<b>X I</b>	
Class X student in school with boarding facilities ×							0.680	0.999	0.469	
At least one parent completed at least higher secondary										
education							(1.048)	(1.293)	(1.160)	
Class XII student in school with boarding facilities ×							0.412	0.269	0.031	
At least one parent completed at least higher secondary								(0.938)		
education							(1.172)		(1.254)	
Class X student in school with boarding facilities ×							0.381	-0.439	0.211	
Student has access to computer at home							(0.891)	(0.528)	(0.817)	
Class XII student in school with boarding facilities ×							-2.328***	-0.808	-1.094*	
Student has access to computer at home							(0.776)	(0.619)	(0.630)	
Class X student in school with boarding facilities ×							0.066	0.061	-0.126	
Number of siblings							(0.191)	(0.168)	(0.168)	
Class XII student in school with boarding facilities ×							-0.055	-0.060	0.110	
Number of siblings	VEO	VEO	VEO	NO	NO	NO	(0.263)	(0.243)	(0.202)	
	YES	YES	TES	NO	NO	NO	NO	NO	NO	
	NU	NO	NU	NU	NU	NO	TES	TES	YES	
Constant	1.819	4.470^^^	11.076***	-3.823**	2.327**	(1.556^^^	2.199	7.125***	11.165***	
Observations	(1.320)	(1.331)	(1.961)	(1.589)	(1.115)	(1.051)	(1.973)	(1.798)	(2.093)	
	5,448	5,448	5,448	3,767	3,767	3,767	3,767	3,767	3,767	
ρκ∠q i ¤B2a2	0.534	0.534	0.534	0.447	0.447	0.447	0.488	0.488	0.488	
pR2q2	0.530	0.530	0.530	0.445	0.445	0.445	0.487	0.487	0.487	
ркида	0.529	0.529	0.529	0.432	0.432	0.432	0.482	0.482	0.482	

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Variable	Class	XII English	Score	Class	XII Dzongkha	Score
	(1)	(2)	(3)	(1)	(2)	(3)
Student and household characteristics						
Class X English score	0.914***	0.919***	0.919***			
	(0.012)	(0.012)	(0.012)			
Class X Dzongkha score				0.852***	0.899***	0.864***
				(0.010)	(0.011)	(0.011)
Student is male	-0.856***	-0.917***	-0.864***	-0.804***	-0.745***	-0.808***
	(0.174)	(0.188)	(0.185)	(0.169)	(0.193)	(0.181)
Student has access to computer at home	0.744***	0.939***	1.015***	0.393**	0.259	1.040***
	(0.204)	(0.218)	(0.354)	(0.196)	(0.219)	(0.343)
Student has access to mobile phone at home	0.672	0.799	0.791	1.231*	1.536**	1.418**
	(0.664)	(0.712)	(0.699)	(0.639)	(0.726)	(0.680)
Student has access to television at home	0.068	0.070	0.143	-0.418	-0.402	-0.318
	(0.306)	(0.333)	(0.331)	(0.295)	(0.340)	(0.322)
At least one parent completed at least higher secondary education	0.901***	0.835***	1.269***	0.502**	0.649**	0.343
[compared with student without parents (deceased or not living	(0.264)	(0.281)	(0.377)	(0.254)	(0.286)	(0.367)
with the child) or parent/s had primary education or lower only]						
At least one parent completed at least middle or lower secondary	0.021	0.048	0.001	-0.193	-0.314	-0.246
education [compared with student without parents (deceased or	(0.269)	(0.288)	(0.284)	(0.259)	(0.294)	(0.276)
not living with the child) or parent/s had primary education or						
lower only]						
Number of siblings	-0.097**	-0.091*	-0.177**	0.049	0.084*	-0.012
	(0.044)	(0.047)	(0.087)	(0.042)	(0.048)	(0.084)
School characteristics	· · · · ·		· · · ·		· · ·	· · ·
School has boarding facilities		0.167	2.273***		1.328***	1.379**
·		(0.230)	(0.655)		(0.235)	(0.659)
School is located in urban area		0.355	2.116***		-0.151	1.270***
		(0.228)	(0.377)		(0.233)	(0.369)
Class XII class size		0.093***	-0.075 <sup>*</sup>		0.131***	Ò.087**
		(0.025)	(0.043)		(0.025)	(0.042)
Number of Class XII English teachers		-0.071	-0.166		( )	( )
5		(0.095)	(0.137)			
Number of Class XII Dzongkha teachers		()	()		0.451***	0.878***
3					(0.103)	(0.139)
Number of computers available to all students		0.007**	0.020***		-0.017***	-0.040***
		(0.004)	(0.005)		(0.004)	(0.005)
Residential interaction with household characteristics			\ · · · · /			· · · · /
School has boarding facilities × At least one parent			-0.946*			0.230
completed at least higher secondary education			(0.534)			(0.520)

#### Table B1: Linear Regression Results for English and Dzongkha Exam Scores Excluding Voluntary Switchers

Continued on the next page

Variable	Class XII English Score Class XII Dzongkha Score						
	(1)	(2)	(3)	(1)	(2)	(3)	
School has boarding facilities × Student has access to			-0.276			-1.041**	
computer at home			(0.438)			(0.426)	
School has boarding facilities × Number of siblings			0.092			0.115	
			(0.103)			(0.100)	
SCHOOL FIXED EFFECTS	YES	NO	NO	YES	NO	NO	
DISTRICT FIXED EFFECTS	NO	NO	YES	NO	NO	YES	
Constant	6.351***	2.737**	0.293	7.226***	-0.232	3.282**	
	(0.985)	(1.157)	(1.585)	(0.914)	(1.205)	(1.513)	
Observations	4,013	3,639	3,639	4,010	3,636	3,636	
R-squared	0.698	0.675	0.691	0.732	0.670	0.715	

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

#### Table B2: Quantile Regression Results for English Exam Scores Excluding Voluntary Switchers

		Model 1			Model 2			Model 3	
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75
Student and household characteristics									
Class X English score	0.942***	0.912***	0.905***	0.944***	0.926***	0.909***	0.947***	0.917***	0.912***
	(0.010)	(0.013)	(0.018)	(0.019)	(0.013)	(0.017)	(0.016)	(0.014)	(0.016)
Student is male	-0.844***	-0.703**	-0.571**	-0.978***	-0.773***	-0.801***	-0.749**	-0.810***	-0.793***
	(0.154)	(0.322)	(0.245)	(0.250)	(0.245)	(0.256)	(0.294)	(0.232)	(0.234)
Student has access to computer at home	0.603**	0.555**	0.514*	0.903***	0.564*	0.937***	0.797	0.602	1.062**
	(0.242)	(0.280)	(0.271)	(0.326)	(0.317)	(0.362)	(0.622)	(0.478)	(0.472)
Student has access to mobile phone at home	0.728	0.780	2.029	0.148	0.132	1.401	-0.178	0.995	1.828*
	(1.126)	(0.726)	(1.489)	(1.005)	(0.830)	(1.014)	(1.323)	(0.900)	(1.052)
Student has access to television at home	0.122	0.513	0.456	0.362	0.416	0.487	0.466	0.404	0.324
	(0.468)	(0.408)	(0.476)	(0.407)	(0.403)	(0.556)	(0.387)	(0.492)	(0.434)
At least one parent completed at least higher	0.548	0.973**	1.496***	0.492	0.893**	1.297***	0.870	1.521***	1.523***
secondary education [compared with student without	(0.443)	(0.412)	(0.310)	(0.373)	(0.401)	(0.413)	(0.725)	(0.485)	(0.505)
parents (deceased or not living with the child) or									
parent/s had primary education or lower only]									
At least one parent completed at least middle or lower	0.003	0.420	0.008	-0.350	0.370	0.120	-0.001	0.383	0.094
secondary education [compared with student without	(0.345)	(0.332)	(0.286)	(0.367)	(0.413)	(0.398)	(0.390)	(0.385)	(0.329)
parents (deceased or not living with the child) or									
parent/s had primary education or lower only]									
Number of siblings	-0.079	-0.057	-0.069	-0.041	-0.075	0.003	-0.258	-0.091	-0.028
	(0.069)	(0.044)	(0.055)	(0.088)	(0.063)	(0.079)	(0.158)	(0.109)	(0.181)
School characteristics									
School has boarding facilities				-0.014	-0.291	0.110	1.480	2.631***	1.971*
				(0.320)	(0.268)	(0.220)	(1.020)	(0.950)	(1.023)
School is located in urban area				0.253	0.442*	0.393	2.657***	2.420***	1.711**
				(0.325)	(0.232)	(0.300)	(0.437)	(0.575)	(0.705)
Class XII class size				0.125***	0.064*	0.078**	-0.026	-0.143**	-0.071
				(0.046)	(0.035)	(0.033)	(0.063)	(0.060)	(0.072)
Number of Class XII English teachers				-0.169	-0.068	0.056	-0.251	-0.346	-0.096
				(0.143)	(0.083)	(0.115)	(0.176)	(0.227)	(0.170)
Number of computers available to all students				0.014**	0.011**	0.006	0.021**	0.024***	0.022***
	-			(0.007)	(0.006)	(0.004)	(0.009)	(0.007)	(0.005)
Residential interaction with household characteris	tics								
School has boarding facilities × At least one parent							-0.737	-1.376	-0.229
completed at least higher secondary education							(0.831)	(1.008)	(0.793)
School has boarding facilities × Student has access							-0.159	-0.045	-0.689
to computer at home							(0.637)	(0.488)	(0.519)

		Model 1			Model 2			Model 3		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75	
School has boarding facilities × Number of siblings							0.252*	0.031	-0.073	
							(0.136)	(0.116)	(0.198)	
SCHOOL FIXED EFFECTS	YES	YES	YES	NO	NO	NO	NO	NO	NO	
DISTRICT FIXED EFFECTS	NO	NO	NO	NO	NO	NO	YES	YES	YES	
Constant	1.672	6.040***	8.928***	-2.837*	3.697**	5.825***	-5.835**	1.626	3.169	
	(1.255)	(1.155)	(1.561)	(1.713)	(1.640)	(1.489)	(2.384)	(2.104)	(2.372)	
Observations	4,013	4,013	4,013	3,639	3,639	3,639	3,639	3,639	3,639	
pR2q1	0.457	0.457	0.457	0.432	0.432	0.432	0.452	0.452	0.452	
pR2q2	0.476	0.476	0.476	0.453	0.453	0.453	0.467	0.467	0.467	
pR2q3	0.472	0.472	0.472	0.448	0.448	0.448	0.461	0.461	0.461	

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

#### Table B3: Quantile Regression Results for Dzongkha Exam Scores Excluding Voluntary Switchers

Variable		Model 1			Model 2			Model 3	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75
Student and household characteristics									
Class X Dzongkha score	0.895***	0.872***	0.842***	0.945***	0.923***	0.882***	0.909***	0.882***	0.858***
	(0.013)	(0.014)	(0.016)	(0.019)	(0.016)	(0.016)	(0.013)	(0.013)	(0.019)
Student is male	-0.944***	-0.594***	-0.313	-0.987***	-0.552*	-0.242	-0.945***	-0.650**	-0.427*
	(0.245)	(0.170)	(0.272)	(0.314)	(0.314)	(0.247)	(0.279)	(0.263)	(0.244)
Student has access to computer at home	0.353	0.541**	0.583**	0.312	0.409	0.252	0.924**	1.070**	0.976*
	(0.335)	(0.262)	(0.293)	(0.373)	(0.257)	(0.326)	(0.397)	(0.467)	(0.532)
Student has access to mobile phone at home	0.343	1.353**	0.915	1.464	1.070*	1.972***	1.433	1.190*	1.697**
	(0.807)	(0.620)	(0.712)	(1.040)	(0.555)	(0.639)	(1.064)	(0.631)	(0.734)
Student has access to television at home	-0.182	-0.558	-0.617	-0.542	-0.592*	-0.676*	-0.723	-0.529	-0.832**
	(0.397)	(0.447)	(0.451)	(0.392)	(0.355)	(0.348)	(0.548)	(0.382)	(0.408)
At least one parent completed at least higher secondary	0.507	0.453	0.587	0.737	0.933**	0.519	0.303	0.105	0.663*
education [compared with student without parents	(0.435)	(0.359)	(0.413)	(0.529)	(0.388)	(0.501)	(0.650)	(0.588)	(0.350)
(deceased or not living with the child) or parent/s had									
primary education or lower only]									
At least one parent completed at least middle or lower	-0.171	-0.276	-0.183	-0.314	-0.359	-0.457	-0.059	-0.231	-0.022
secondary education [compared with student without	(0.367)	(0.241)	(0.384)	(0.353)	(0.440)	(0.506)	(0.305)	(0.379)	(0.312)
parents (deceased or not living with the child) or parent/s									
had primary education or lower only]									
Number of siblings	0.094	0.075	0.064	0.080	0.094*	0.087	-0.019	0.097	0.067
-	(0.076)	(0.068)	(0.056)	(0.080)	(0.054)	(0.061)	(0.143)	(0.095)	(0.104)
School characteristics									
School has boarding facilities				0.994**	1.100***	1.228***	0.728	2.502***	2.197**
				(0.403)	(0.326)	(0.273)	(0.932)	(0.892)	(1.032)
School is located in urban area				-0.579**	-0.244	0.529**	0.904*	1.177**	1.590***
				(0.245)	(0.283)	(0.231)	(0.470)	(0.542)	(0.531)
Class XII class size				0.115***	0.096***	0.114***	0.121 <sup>*</sup>	-0.033	-0.000
				(0.036)	(0.029)	(0.038)	(0.068)	(0.067)	(0.057)
Number of Class XII Dzongkha teachers				0.529***	0.453***	0.516***	1.015***	0.853***	0.791***
ů				(0.133)	(0.163)	(0.116)	(0.136)	(0.159)	(0.164)
Number of computers available to all students				-0.012***	-0.014***	-0.029***	-0.042***	-0.032***	-0.039***
				(0.004)	(0.004)	(0.006)	(0.008)	(0.007)	(0.006)
Residential interaction with household characteristics				, <i>,</i> ,	· · · /	· · · /	, <i>i</i>	, , , , , , , , , , , , , , , , , , ,	. ,
School has boarding facilities × At least one parent							0.638	0.589	-0.027
completed at least higher secondary education							(0.924)	(0.790)	(0.760)
School has boarding facilities × Student has access to							-0.929*	-1.008*	-0.711
computer at home							(0.537)	(0.543)	(0.622)

Variable		Model 1			Model 2			Model 3	del 3	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75	
School has boarding facilities × Number of siblings							0.080	-0.003	0.051	
							(0.171)	(0.110)	(0.158)	
SCHOOL FIXED EFFECTS	YES	YES	YES	NO	NO	NO	NO	NO	NO	
DISTRICT FIXED EFFECTS	NO	NO	NO	NO	NO	NO	YES	YES	YES	
Constant	2.513*	6.413***	11.605***	-5.564***	-0.003	5.053***	-1.361	4.492**	7.840***	
	(1.311)	(1.044)	(1.226)	(1.644)	(1.516)	(1.846)	(1.603)	(2.114)	(1.985)	
Observations	4,010	4,010	4,010	3,636	3,636	3,636	3,636	3,636	3,636	
pR2q1	0.495	0.495	0.495	0.438	0.438	0.438	0.479	0.479	0.479	
pR2q2	0.497	0.497	0.497	0.439	0.439	0.439	0.477	0.477	0.477	
pR2q3	0.493	0.493	0.493	0.427	0.427	0.427	0.471	0.471	0.471	

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

#### REFERENCES

- Asian Development Bank (ADB). 2022. Falling Further Behind: The Cost of COVID-19 School Closures by Gender and Wealth: Special Topic of the Asian Development Outlook 2022. Manila.
- Azevedo, João Pedro, Maryam Akmal, Marie-Hélène Cloutier, Halsey Rogers, and Yi Ning Wong. 2022. "Learning Losses During COVID-19: Global Estimates of an Invisible and Unequal Crisis." Education Global Practice Policy Research Working Paper 10218. World Bank, Washington, DC.
- Azevedo, João Pedro, Amer Hasan, Diana Goldemberg, Koen Geven, and Syedah Aroob Iqbal. 2021. "Simulating the Potential Impacts of COVID-19 School Closures on Schooling and Learning Outcomes: A Set of Global Estimates." *The World Bank Research Observer* 36 (1): 1–40.
- Bhutan Council for School Examinations and Assessment (BCSEA), and Organisation for Economic Cooperation Development (OECD). 2019. "Education in Bhutan: Findings from Bhutan's Experience in PISA for Development." Thimphu, BCSEA National Project Centre.
- Dela Cruz, Nina, Ann Adona, Rhea Molato-Gayares, and Albert Park. 2024. "Learning Loss and Recovery from the COVID-19 Pandemic: A Systematic Review of Evidence." Economics Working Paper 717. Asian Development Bank, Manila.
- Donnelly, Robin, and Harry Patrinos. 2022. "Learning Loss During Covid-19: An Early Systematic Review." *Prospects* 51 (4): 601–9.
- Gough, Jean. 2020. "Urgent Action Is Required to Protect the Learning of All South Asian Children." UNICEF South Asia Blog Post, 23 November. <u>www.unicef.org/rosa/stories/urgent-action-required-protect-learning-all-south-asian-children</u>
- Hammerstein, Svenja, Christophe König, Thomas Dreisörner, and Andreas Frey. 2021. "Effects of COVID-19-Related School Closures on Student Achievement: A Systematic Review." *Frontiers in Psychology* 12 (746289). <u>https://doi.org/10.3389/fpsyg.2021.746289</u>
- Ministry of Education and Skills Development. 2021. *Annual Education Statistics* 2021. Policy and Planning Division. Thimphu.

- Ministry of Education and Skills Development, Helvetas Bhutan, and United Nations Children's Fund (UNICEF). 2021. "Education in Emergency (EiE) During COVID-19 Report." <u>www.unicef.org/bhutan/reports/education-emergency-eie-during-</u> <u>covid-19-report</u>
- Moscoviz, Laura, and David Evans. 2022. "Learning Loss and Student Dropouts During the COVID-19 Pandemic: A Review of the Evidence Two Years After Schools Shut Down." Working Paper 609. Center for Global Development, Washington, DC.
- Norbu, Tshewang, and Tenzin Namgyel. 2019. "Languages and Technology in Bhutan." *Proceedings of the Language Technologies for All (LT4All),* pp. 235–238, Paris 5–6 December.
- Pokhrel, Sumitra, and Roshan Chhetri. 2021. "A Literature Review on Impact of COVID-19 Pandemic on Teaching and Learning." *Higher Education for the Future* 8 (1): 133–41.
- Rai, Anita, Sapna Thapa, Jamyang Thinley, Namgay Wangchuk, and Dechen Pelki.
   2018. "Use of Mobile Application in Dzongkha Learning." *ZorigMelong: A Technical Journal* 4 (1): 24–27.
- Singh, Abhijeet. 2015. "Private School Effects in Urban and Rural India: Panel Estimates at Primary and Secondary School Ages." *Journal of Development Economics* 13: 16–32.
- United Nations Children's Fund (UNICEF), and United Nations Educational, Scientific and Cultural Organization (UNESCO). 2021. "Bhutan Case Study: Situation Analysis on the Effects of and Responses to COVID-19 on the Education Sector in Asia." www.unicef.org/rosa/media/16496/file/Bhutan%20Case%20Study.pdf
- United Nations Educational, Scientific and Cultural Organization (UNESCO). 2023. "Global Education Monitoring Report: Bhutan Technology in Education." Profiles Enhancing Education Reviews (PEER). <u>https://education-profiles.org/central-and-</u> <u>southern-asia/bhutan/~technology</u>
- World Bank, United Nations Educational, Scientific and Cultural Organization (UNESCO), and United Nations Children's Fund (UNICEF). 2021. The State of the Global Education Crisis: A Path to Recovery. Washington, DC, Paris, and New York.
- Zierer, Klaus. 2021. "Effects of Pandemic-Related School Closures on Pupils' Performance and Learning in Selected Countries: A Rapid Review." *Education Sciences* 11 (6): 252. <u>https://doi.org/10.3390/educsci11060252</u>

# Determinants of Student Performance During the COVID-19 Pandemic School Closure in Bhutan

This paper explores Bhutanese students' performance during the coronavirus disease pandemic using value-added econometric models and high-stakes exam data. Surprisingly, gender, urban-rural, and socioeconomic gaps remained stable. Key predictors of performance among school and household characteristics are identified. While computer ownership boosted English scores, its impact on Dzongkha was limited due to fewer online learning resources for the national language. Quantile regression analysis suggests that boarding facilities were vital for preventing disadvantaged students from falling farther behind during school closures.

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