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School innovation for continuous learning in the period of a health shock and pupils' mental wellbeing in Burkina Faso and Ethiopia

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ABSTRACT

This study focuses on the psychological consequences of school innovation for ongoing learning during the COVID-19 lockdown, which includes teaching strategies that use both online and offline (e.g. telephone-based instruction) teaching methods. Based on survey data obtained from Burkina Faso and Ethiopia, as collected by UNESCO/IEA, it is evident that the existence of learning innovation in schools is associated with a significant reduction in the likelihood of children reporting poor mental health and experiencing negative emotions. The results indicate that the gender of teachers and students, and the location of the schools, play a significant role in influencing the outcomes.

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1. Introduction

Discussions about the relative effectiveness of technologically driven innovative approaches and those that are not driven by technology to improve student learning continue, particularly during the times when schools are closed to stop the COVID-19 virus's spread. What the payoff to such innovation should be is still the main topic of contention in the discussion. Studies have shown that learning worsens, especially for students with low ability (Alpert, Couch, and Harmon 2016; Cacault et al. 2021; Kofoed et al. 2021). However, additional experimental data from Ghana, Pakistan, Niger, and India indicate significant educational improvements by integrating technology into the learning process (Aker and Ksoll 2019; 2020; Johnston and Ksoll 2017). Some have noted that the effect primarily depends on the institutional setting (Escueta et al. 2017). Recent findings from the COVID-19 pandemic demonstrate that learning loss can be minimized while under lockdown constraints by using innovative teaching and learning strategies (Angrist et al. 2020). However, additional study is urgently required in the context of underdeveloped countries to ascertain how implementing learning innovations for continuous learning during the lockdown affects the mental health conditions of affected pupils.

There are strong reasons to suspect that adapting the teaching strategy for continuous learning¹ throughout the pandemic may have an impact on the mental health of pupils. First, if regular schooling is stopped in a way that interferes with students' education, they are more likely to experience mental health issues because their expectations for the future are lower, they have fewer opportunities to interact with friends and teachers, they are less physically active, and they feel more alone (Fegert et al. 2020). As a result, by enabling students to communicate with teachers and other pupils as a kind of

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psychological and psychosocial support, schools that alter their teaching approach may assist students in coping with lockdown issues. Second, by continuing learning during the school closure, children's exposure to adults' negative emotions about the loss of learning might be reduced. This notion is further supported by the expanding body of literature on family circumstances and parents' effects on children's mental health (Mork, Sjogren, and Svaleryd 2020). Continuous learning may have reduced parental stress to support the child's learning, depression, and anxiety during the lockdown, all of which are key causes of an adverse childhood experience (Colvin, Reesman, and Glen 2022).

In the context of poor public policies to shield households from the pandemic's economic shocks and the prevalence of children with poor mental health conditions, this study examines the mental health effects of adopting technological (e.g. online methods) and non-technological (e.g. sending paper materials home and telephone-based teaching) approaches for continuous learning during the pandemic lockdown. It relies on data gathered by the UNESCO International Association for the Evaluation of Educational Achievement during the Covid-19 school shutdown period. The survey includes detailed information about the schools' innovative actions to towards students' continuous learning, how the lockdown disrupted teaching operations, and student-centered information, including their mental well-being. This data is used to specifically assess correlations by examining the effects of innovative learning approaches that are computer-based (online, for example, virtual learning) and non-computer-based (offline, for example, sending paper materials home, telephone-based teaching). It estimates associations with negative emotional occurrences, such as feeling more lonely than usual, getting upset over things that would not have normally been a bother, feeling angrier, not feeling like contacting friends (i.e. social isolation), and feeling more worried than usual about friends and family getting sick.

The empirical approach recognizes the possibility of endogeneity with the measure of school innovation for continuing learning. One that comes to mind is that a school's decision to innovate its teaching and learning process may not be exogenous but rather determined by the actions of other schools within a specific cluster (Boboms and Finan 2009; McConnell, Montplaisir, and Offerdahl 2020). In an attempt to address this concern, I estimate an instrumental variable regression that relies on the intensity of innovative learning during the COVID-19 lockdown by other schools within the cluster (i.e. locality) as an exogenous variation in the likelihood of adopting such an approach. This design separates alternative explanations in a manner that adds credibility to the understanding of the effectiveness of learning innovation during Covid-19 lockdown for pupils' mental well-being.

The results suggest a robust correlational evidence, showing that pupils in schools with innovations for continuing learning during the school closure period are significantly less likely to report higher negative emotional scores. At the same time, they are less likely to report feeling more lonely than usual, upset over things that would not have been a bother, often feeling angrier than usual, and more worried about the conditions of friends and family. These results are consistent with alternative estimates when addressing endogeneity concerns.

With the exception of a few outcomes, the estimates reveal essentially minimal heterogeneity, which refers to whether the direction of the effect depends on the gender of the teacher and the student. For example, while male students are significantly less likely than female students to feel angrier, students in classrooms with female teachers at innovative schools report less social isolation. Regarding the spatial differences in the results, I find that some of the positive correlations of school innovation on pupils' mental well-being are only seen in schools in cities and towns. Pupils in schools in communities, mostly rural and low-income households, do not record any mental well-being benefits from the learning innovation. The results also suggest that the innovation enhanced learning and other support systems for pupils to cope with the lockdown restrictions, which may have positively affected the mental well-being of pupils. Therefore, apart from continuing learning during the pandemic disruption, schools with such learning innovations may have enhanced their support systems for pupils to cope with the pandemic.

The results of this study add to the body of knowledge on the psychological benefits of school innovation amid an overwhelming health shock. Current research reveals contradictory findings.

While some studies find a positive impact (Charbonnier et al. 2022) others find negative effects, noting that the mental health of students is negatively impacted by social isolation brought on by decreased physical interaction and concentration deficit in virtual classes (Alpert, Couch, and Harmon 2016; Bird, Castleman, and Lohner 2020; Kofoed et al. 2021). In agreement, other studies note significant negative effects from teaching- and learning innovation during the pandemic, such as students' inability to maintain motivation, finish coursework, and a sense of social isolation from teachers and classmates (Kaur and Joordens 2021; Sarikaya 2021; Shim and Lee 2020). Others, however, discover that the impact of learning innovation on students' emotional state is dependent on the availability of high-quality infrastructure, logistical issues, or the inability of innovative activities to adjust to students' requirements (Balta-Salvador et al. 2021; Khalil et al. 2020). Our study provides the first systematic assessment of the relationship between education systems' innovative approach to continuous learning during the pandemic in this context and pupils' mental health by concentrating on two low-income countries, Ethiopia and Burkina Faso, with persistently poor public policies to protect households from the financial consequences of prevailing health shocks and fragile health systems to address the rising children's mental health crisis (UNICEF 2021).

2. Study context

In Burkina Faso and Ethiopia, the national ministry of education issues guidelines and directions to schools regarding best practices for teaching and learning. The national education policies must be put into practice by the regional governments or Regional Education Bureaus (in Ethiopia). Ethiopian schools, unlike those in Burkina Faso, have some discretion over how to carry out the prescribed curriculum and the country's educational policy, including how to alter schedules for classes in accordance with enrollment and resource constraints.

The Burkinabe education administration system remained unchanged by the pandemic lockdown, with the exception that private schools were given a little bit more freedom to choose their own methods of instruction (Meinck, Fraillon, and Strietholt 2022). Nevertheless, the Ministry of Education's national response plan gave all schools instructions and digital resources, including support measures, to enable remote learning and offer a secure environment for pupils to learn in. The resources provided to schools and instructors include radio broadcasts, television programming (which may be accessed via the Ministry of Education website), printed materials, computers, and other ICT resources. Meinck, Fraillon, and Strietholt (2022) reports that there is also access to the internet, video conferencing software, and help for teachers on how to use these tools and produce digital learning materials.

Additionally, professional development courses are provided to Ethiopian teachers and schools in the field of ICT-related competencies (Meinck, Fraillon, and Strietholt 2022). Paper-based resources, television programs, and electronic platforms were used to distribute reading materials, notes, and assignments to students. Schools with access to these resources were mandated to use them by the regulators, and radio and audio broadcasts continued to be employed to enhance remote learning practices.

The lockdown resulted in guidance and policies that were intended to ensure continuous learning. Perhaps, not all schools or students benefit from these strategies, as some the implementations of remote learning innovations depended on school resources, household resources, school remoteness, and other institutional factors (Kim et al. 2021; UNESCO 2022). Therefore, given the divergence in school implementation of the remote learning initiative during the Covid-19 lockdown, it is imminent to learn about the mental health consequences on pupils who benefited from such initiative relative to those who did not. This inquiry is relevant in this context, noting the adverse effect of the lockdown on pupils' mental well-being (Charbonnier et al. 2022) and access to mental health and psychosocial support services remains unequal for children and adolescents in this region (UNICEF 2021).

3. Data and empirical strategy

3.1. Data

The data used in this paper comes from the UNESCO/ International Association for the Evaluation of Educational Achievement (IEA) survey, conducted between April to June 2021 for Burkina Faso (28 April – 18 June, 2021) and Ethiopia (14–25 June, 2021).² The survey was conducted on schools/principals (secondary), teachers, and pupils.³ It sought to reach the target demographics in these countries, but it was constrained by particular factors, such as conflict incidence in some of the regions. Prior to sample selection, schools in the impacted areas were excluded from the sample frame. Therefore, when evaluating the findings of this study, this limitation should be taken into account.

Two stages of stratified random sampling are used to collect survey data.⁴ Selection of schools is the first step,⁵ followed by the selection of teachers and students. Before random selection, schools were stratified by urbanization, funding type, and region of location to improve sample efficiency and facilitate heterogeneous analyses. In each country, information about school innovation during the school closure period is obtained from the principal and from teachers, along with detailed information about the school innovation during the school closure period. The data on the school's innovative activities came from a survey of the school and its teachers, in which the principal and a teacher were asked whether the school had participated in any of the cutting-edge initiatives to continue instruction during the period of school closure. The student-level survey provides further details regarding the state of the sampled students' mental health. As a result, I combined the three levels of surveys using the specific school identification when using the surveys for analysis. The definitions of the variables used in the analysis of this study are provided in detail in the next subsection.

3.2. School innovation

School innovation is defined broadly as actions taken by schools towards continuous learning for students during the Covid-19 school closure period. This definition fits Esdal's (2017) four-dimensional definition of innovation in education, surmised as doing things differently. Hence, this variable was taken from the school- and teacher-level survey information, measured as a binary indicator - if the school continued learning engagement during the school closure period, through any of the following means – online methods only (computer-based), and online and offline methods (non-computer-based, e.g. sending paper-materials home, telephone-based teaching). To improve this study's analysis power, schools that engaged online and offline teaching methods were regarded as having an innovative approach to education during the Covid-19 lockdown. Schools that engage in innovative practices are those where there is an overlap in the school and teacher response of engaging in such practices during the lock-down period, in order to reduce bias in this measure.

3.3. Mental well-being

This variable was based on student-level survey questions regarding the assessment of the following statements about their well-being during the Covid-19 disruption: These emotions include feeling more lonely than usual, getting upset over things that would not have normally been a bother, feeling angry more often than usual, not feeling like contacting friends (i.e. social isolation), feeling more worried than usual about friends and family getting sick. These indicators are similar to other measures of mental well-being that ask individuals about negative emotional states experienced during a specific period (Adhvaryu, Fenske, and Nyshadham 2019). I recoded the responses to these emotions as '1' if the student's response is affirmative ('strongly agree' and 'agree') and '0' if the response is 'disagree' and 'strongly disagree.' Following Sharma, Singhal, and Tarp (2021) approach,

I further define a mental well-being score as the summative of the response to five negative emotions, such that higher values '5' imply higher negative emotions and '0' imply better mental health.⁶ The analysis considers this mental well-being score and specific indicators of the different emotions.

3.4. Other covariates

Respondents self-reported demographic information, such as the gender and age of the principal, the teacher, and the student. Teachers self-reported their experiences, while the principal provided information about the school population, ownership status, and location.

3.5. Empirical strategy

I estimate Equation (1), a linear regression specification that accounts for a number of factors related to the mental health of students. The exact specification for pupil i taught by teacher t in school s in country c is:

$$\text{Mental health}_{itsc} = \alpha + \beta \text{Innovate}_{tsc} + \gamma X_{its} + t_t + s_s + c_c + \varepsilon_{itsc} \quad (1)$$

$\text{Mental health}_{itsc}$ indicates the mental health score and the individual indicators of the pupil's mental wellbeing. Innovate_{tsc} is the indicator for the school innovation to continue learning during the Covid-19 lockdown period, while X_{its} are the diverse covariates for the observable characteristics of the school/principal, the teachers, and the pupils. Specifically, I control for the principal's and teacher's age, gender, and experience in the school to capture ability to manage stress and leadership effectiveness (Maelen et al. 2020; Richardson 2020; Woo and Steiner 2022). School population and ownership could reflect the frequency of job-related stress, the quality of access to school resources and teacher engagement, which may determine pupils' mental wellbeing (Jakobsson, Persson, and Svensson 2013; Watt 2003; Woo and Steiner 2022). The pupil's age also matters in determining mental health because of physiological changes that explain social and emotional habits important for mental well-being (WHO 2021; UNICEF 2022).

Apart from the observable characteristics of the school/principal and teacher, I include fixed effects at school and teacher levels (t_t and s_s), and at the country level (c_c) to adjust for any fixed and unobservable differences at these three levels. The fixed effects also account for confounding variations that occur at these three levels that may influence both the outcome variable and the primary explanatory variable. The usual standard error, clustered at the school level, is represented in Equation (1) as ε_{itsc} . This approach accounts for serial correlation within schools. Linear regression was used to test for associations, while robustness checks to underscore the sensitivity of the results to other analytical threats are discussed in the subsequent sections.

In Equation (1), there is a specific threat to our identification: that school innovation is not random, since it may be influenced by peer effects and parental pressures to implement such innovation (Boboms and Finan 2009; McConnell, Montplaisir, and Offerdahl 2020). Schools within specific clusters, for example, may feel pressure to innovate their processes once other schools within those clusters also take innovative steps to continue learning during the lockdown. Parental pressures may also explain the non-adoption of an innovative approach, especially when the child perceives innovation to be too stressful, causing the parent to push back. Further, the types of students who attend innovative schools may be those who are motivated and capable of learning.

Within an instrumental variable framework, therefore, one can account for this endogeneity concern by leveraging variation in the intensity of adoption of school innovation by other schools in a specific cluster apart from the sampled schools. This instrument has appeal because the intensity of adopting innovative changes to continue learning during the lockdown by schools within a specific cluster, other than the focal school, should be predictive of the decision to adopt similar

changes by the focal school. Previous studies have established the existence of the peer effect as a driver of cluster-level innovation adoption (Bailey et al. 2022; Machokoto, Gyimah, and Ntim 2021).

The identifying assumption is that the cluster average of adopting teaching innovation only influences the psychological distress of pupils in the focal schools because their school have adopted similar innovation. This assumption is supported by the fact that Covid-19 lockdown hampered social interactions within clusters, leading to more individual and household isolation, and pupils may not have the opportunity to interact with other pupils and their teachers outside of such innovations. Hence, a pupil's mental health can only be affected through changes in the teaching innovation of their specific school, informed by peer effects from other schools within the same neighborhood. Nevertheless, one cannot claim absolute exogeneity, as the possibility of violations of this identifying assumption could take any form, including unobserved shocks that appear to be correlated with the cluster innovation and influence both the focal school innovation adoption and the pupil's mental health.

I estimate the following two-stage least squares instrumental variable regression specification in a robustness analysis, as follows:

$$\text{Innovate}_{itsc} = \alpha + \beta \text{Inst}_c + \gamma X_{its} + t_t + s_s + c_c + \varepsilon_{itsc} \quad (2)$$

$$\text{Mental health}_{itsc} = \alpha + \beta \widehat{\text{Innovate}}_{itsc} + \gamma X_{its} + t_t + s_s + c_c + \varepsilon_{itsc} \quad (3)$$

Where in Equation (2) Inst_c is the exogeneous instrument representing the cluster average of the intensity of the adoption of innovation for continuous learning by other schools apart from the focal school. Similar to Equation (1), all the other identifiers (i.e. X_{its} , t_t , s_s , c_c , and ε_{itsc}) are as earlier defined. The 2SLS estimation yields the average effect of the likelihood of adopting school innovation for those groups who actually innovated their school learning procedure during the Covid-19 pandemic lockdown.

4. Results

4.1. Descriptive

The final sample of 138 schools in Burkina Faso (2,474 pupils) and 186 schools in Ethiopia (3,621 pupils) is the earliest demographically representative study of students in the two countries. In contrast to surveys that were previously gathered during other periods, this survey was designed and implemented during a global pandemic, which explains the small sample size (UNESCO/IEA, 2022). However, Table 1 indicates that 11.5% of the schools positively engaged in innovative adjustments in their service delivery for teaching and learning, including using online (computer-based) methods, hybrid methods of engaging online (computer-based) and offline methods (for example, sending paper materials home, telephone-based teaching), and using offline methods only (non-computer-based methods), such as sending paper materials home.

The incidence of mental health issues among pupils from both countries during the COVID-19 lockdown further suggests poor conditions. The pupils feel at least three negative emotions, such as feelings of loneliness, upset, anger, not feeling like contacting friends, and more worried (see Table 1). Regarding indicators of mental health conditions, 63% of respondents said they felt more lonely than usual, 59.7% said they were more upset over things that normally would not have bothered them, and 52.9% said they were angrier than usual. Worrying is the mental health emotion of most pupils – 76.7% report such emotions – while the least common emotions reported are feelings of isolation or a lack of desire to contact friends.

The summary statistics of the other covariates are shown in Table 1, including the mean statistics of the school, teacher, and pupil characteristics. The regression analysis in the next section will combine data from the two countries while accounting for the country fixed effects to address those concerns with specific unobserved factors that may differ across countries, in order to preserve

Table 1. Summary statistics.

	Mean	SD
<i>Mental health</i>		
Aggregate mental health score	2.714	1.543
Felt more lonely than usual	0.630	0.483
Upset over things that would not have normally bothered me	0.597	0.491
Felt angry more often than usual	0.529	0.499
Did not feel like contacting my friends	0.364	0.481
Was more worried than usual about my friends and family getting sick	0.767	0.423
<i>School innovation</i>		
Innovate	0.115	0.319
<i>Covariates</i>		
Principal's age (1, <30; 2, 30–39; 3, 40–49; 4, 50–59; 5, >60)	2.667	0.983
Principal's age (1 if 40 yrs. and above)	0.506	0.500
Principal's experience in school (1 if 5 years and above)	0.364	0.481
Principal's gender (1 if female)	0.122	0.327
School population (total pupils)	746.425	719.509
School ownership (1 if public)	0.841	0.365
Teacher's experience (1 if 5 years and above)	0.877	0.328
Teacher's age (1, <30; 2, 30–39; 3, 40–49; 4, 50–59; 5, >60)	2.888	0.974
Teacher's age (1 if 30 yrs. and above)	0.656	0.475
Teacher's gender (1 if female)	0.278	0.448
Pupil's age (in years)	14.365	1.711
<i>Other variables</i>		
Pupils' gender (1 if a girl)	0.502	0.500
School location (1 if in the city)	0.550	0.497

the power of the study that may be threatened by sample size reduction, assuming we consider samples for each respective country.

4.2. School innovation during Covid-19 and mental wellbeing

The regression results in Table 2 show a strong relationship between student mental health improvements and school innovation used to engage students during the COVID-19 lockdown. In comparison to schools without innovative education approaches, the average psychological distress among pupils in schools with innovative methods for continuous learning was 0.553 units lower (see column 1). Other measures that significantly correlate with improvement in pupils' aggregate mental well-being are older teachers in the schools, probably because of improved ability to manage high stress with healthy lifestyle choices for better work-life balance (Maelen et al. 2020; Richardson 2020). In addition, class size also correlates with better mental well-being, supporting the influence of peers on students' social satisfaction (Lavy and Sand 2018). The gender of the principal correlates with higher pupil mental distress. Recall that the survey was conducted during the school lockdown period, and this situation may have exacerbated stress levels for women (unlike men) who have to combine the higher burden of unpaid work at home with the burden from school leadership (see UNESCO 2021).

Columns 2–6 shows the effects for the specific indicators of pupils' mental well-being. The mental health indicators, the probability of feeling more lonely than usual, upset over things that would not have normally mattered, angry more often than usual, and more worried than usual, were all significantly and adversely associated with school innovation in continuing learning during the Covid-19 lockdown. The emotions responding the most to school innovation are the likelihood of often feeling worried (by 24 -percentage points decline) and the likelihood of often feeling lonely (by 15.9-percentage points), while often feeling angry saw a decline of 12.1-percentage points and often upset over things that would normally not have been a bother declined by 11.3-percentage points. The indicator of social isolation, such that the student noted no interest in contacting friends, was also negatively associated with school innovation. Although this relationship was not significant, the coefficient's direction aligns with the prediction of the importance of school innovation in improving pupils' mental well-being during periods of health shock.

Table 2. Mental wellbeing and school innovation.

	Aggregate mental health score	Felt more lonely than usual	Upset over things that would not have normally bothered me	Felt angry more often than usual	Did not feel like contacting my friends	Was more worried than usual about my friends and family getting sick
	[1]	[2]	[3]	[4]	[5]	[6]
School innovation	-0.553** (0.244)	-0.159** (0.078)	-0.113*** (0.041)	-0.121** (0.051)	-0.009 (0.032)	-0.240*** (0.065)
Principal's age	0.042 (0.201)	-0.036 (0.055)	0.079 (0.051)	0.066 (0.052)	0.075 (0.057)	0.022 (0.041)
Principal's age (1 if 40 yrs. and above)	0.131 (0.286)	0.093 (0.105)	-0.049 (0.085)	0.002 (0.098)	-0.071 (0.095)	0.069 (0.081)
Principal's experience in school (1 if 5 years and above)	0.004 (0.201)	-0.007 (0.069)	-0.028 (0.054)	-0.015 (0.078)	0.049 (0.057)	-0.018 (0.046)
Principal's gender (1 if female)	0.379** (0.187)	0.105 (0.085)	0.114* (0.063)	0.134** (0.067)	0.035 (0.073)	-0.015 (0.057)
School population (total pupils)	-0.000** (0.000)	-0.000 (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	0.000 (0.000)	0.000* (0.000)
School ownership (1 if public)	-0.073 (0.232)	-0.134* (0.071)	-0.012 (0.063)	0.095 (0.073)	-0.122* (0.070)	0.016 (0.059)
Teacher's experience (1 if 5 years and above)	0.184 (0.214)	0.076 (0.066)	-0.018 (0.071)	0.078 (0.067)	0.012 (0.062)	-0.007 (0.039)
Teacher's age	-0.164 (0.115)	-0.006 (0.028)	-0.045 (0.034)	-0.028 (0.036)	-0.075** (0.034)	-0.051** (0.025)
Teacher's age (1 if 30 yrs. and above)	0.138 (0.206)	-0.048 (0.059)	0.073 (0.065)	0.002 (0.067)	0.085 (0.064)	0.112** (0.051)
Teacher's gender (1 if female)	-0.100 (0.112)	-0.044 (0.036)	-0.029 (0.037)	0.010 (0.039)	-0.011 (0.048)	-0.073** (0.033)
Pupil's age	0.003 (0.014)	-0.005 (0.005)	0.003 (0.005)	0.007 (0.005)	0.009 (0.005)	-0.001 (0.004)
Constant	3.008*** (0.491)	0.895*** (0.168)	0.546*** (0.162)	0.229 (0.168)	0.284* (0.170)	0.802*** (0.134)
Observations	4,754	4,580	4,570	4,543	4,532	4,594
R-squared	0.414	0.342	0.386	0.381	0.363	0.334

Note: Coefficients displayed in the Table are the regression estimates with clustered standard errors at the school level. All regression control for the country-, school-, and teacher- level fixed effects. Although not reported for brevity and conciseness, the main results are consistent even when we do not control for these fixed effects. The values in parenthesis are the standard errors. The superscript are as follows, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.3. Addressing endogeneity concerns and other robustness checks

A. Instrumental Variable Regression

This section now presents the results for the two-stage regression specified in Equations (2) and (3). The instrumental variable approach builds on the results presented in Table 2, showing that students' mental well-being improved with schools adopting innovative ways to continue teaching during the lockdown. Table 3 shows similar results using an instrumental variable that describes the extent of adoption of school innovation for continuous learning by other schools within the community. This instrument is unrelated to the pupils' mental well-being. Although not reported⁷, additional analysis suggests a null correlation between the instrument and the indicators of pupils' mental health, which further verifies this claim. The first-stage regression in the Table further demonstrates the relevance of the instrument in defining school teaching innovation: in each column, the likelihood that the target school will adopt a similar innovation is significantly correlated with the average adoption of teaching innovation by other schools in the cluster. Furthermore, it appears that the instrument is not weak based on the first-stage f-statistic's persistent maintenance of a value above 10 (Stock, Wright, and Yogo 2002).

Table 3. Mental wellbeing and school innovation (IV-Regression Result).

	Aggregate mental health score		Felt more lonely than usual		Upset over things that would not have normally bothered me		Felt angry more often than usual		Did not feel like contacting my friends		Was more worried than usual about my friends and family getting sick	
	[1a]	[1b]	[2a]	[2b]	[3a]	[3b]	[4a]	[4b]	[5a]	[5b]	[6a]	[6b]
<i>Inst</i>	0.166*** (0.032)		0.166*** (0.031)		0.173*** (0.032)		0.169*** (0.033)		0.172*** (0.032)		0.169*** (0.032)	
School innovation		-1.143*** (0.021)		-0.056* (0.028)		-0.491*** (0.034)		-0.827** (0.341)		-0.312 (0.325)		-0.156*** (0.025)
Observations	4,602	4,602	4,427	4,427	4,418	4,418	4,396	4,396	4,385	4,385	4,445	4,445
R-squared	0.012		0.006		0.169		0.008		0.117		0.117	
F-statistics	27.61		28.77		29.17		26.74		29.58		28.58	

Note: Estimates in columns 'a' are the coefficient of the first-stage regression, while columns 'b' are those of the second stage regression. *Inst* is the instrument, measured as the ratio of schools (apart from the focal school) within a specific cluster that have adopted teaching innovation to continue learning during the lockdown. Standard errors are clustered at the school level. All regression includes the following controls principal's age, principal's age (1 if 40 yrs. and above), principal's experience in school (1 if 5 years and above), principal's gender, school ownership (1 if public), teacher's experience (1 if 5 years and above), teacher's age, teacher's age (1 if 30 yrs. and above), teacher's gender, and pupil's age. I also control for the country-, school-, and teacher-level fixed effects. The values in parenthesis are the standard errors. The superscript are as follows, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The key empirical finding from [Table 2](#) that schools using innovative methods to continue the learning process during the lockdown have positive psychological effects on students is supported by the instrumental variable estimates in [Table 3](#). In particular, the overall score for negative emotions dramatically decreased by one unit in column 1b, and the projected coefficient for the risk of feeling more alone than usual significantly decreased by six percentage points in column 2b. As a result, negative emotions like feeling sad about things that normally would not have been a bother and becoming angry more frequently than usual dramatically decreased by 49 percentage points (column 3b) and 83 percentage points (column 4b), respectively. Despite a statistically insignificant drop in the emotion of feeling alone and reluctance to contact friends (column 5b), the results show a significant decline of 16 percentage points in the emotion of being more concerned than usual about friends and relatives falling sick (column 6b).

It is important to reiterate that the instrumental variable regression represents estimates for the subset of the sample that complies with the instrument. It is reassuring, therefore, that schools' innovative adaption of teaching style (i.e. those compliers) during the lockdown period may have contributed to improving pupils' psychological well-being among this sub-sample of individuals.

B. Other Robustness Checks

The results remained essentially unchanged across models in the robustness checks. For instance, the findings remain unchanged when the regression takes into account particular household characteristics, such as the parent's level of education and employment, as well as their marital status, or whether they are married. These factors are crucial for both the adoption of innovations at the household level and the mental wellbeing of a child. As it reflects the potential for increased resource availability in the household for quality investment in the human capital development of the child, the educational level and employment status of parents are important input factors in the human capital production function (Fakhrunnisak and Patria 2022; Fuchs-Schundeln et al. 2022; Mork, Sjogren, and Svaleryd 2020). According to D'Onofrio and Emery (2019), a parent's marital status reveals intra-household marital relationships that are important for a child's mental health. Evidence from Panel A of [Table A1](#) in the appendix suggests that the coefficient's signs and significant values are mostly consistent with those in [Table 2](#).

In a separate check, in Panel B, I include an additional covariate that reflects the level of school resources: the total number of teachers in the school. Panel C adjusts for the sample school weight in the regression analysis, while Panel D adds some child- and household-level controls. The results presented in these additional robustness checks are consistent in signs and significant values with those in [Table 2](#). Overall, the results rule out the possibility that the estimates (in terms of the direction of the association) are sensitive to the number of controls adjusted in the model.

This study has so far established an association between pupil mental well-being and school innovation. The next section presents heterogeneous effects by pupils' and teachers' gender, and geographical location of the schools, to examine how these factors moderate the estimated relationship. It is likely that due to the overwhelming nature of the pandemic shock on the educational system, one may not find a heterogeneous effect by pupils' gender, as male and female pupils may experience similar emotions from school innovation in such a context. In addition, one may find differences in the estimate by the gender of the teacher based on the argument that gender differences in teachers' stress levels due to the pandemic may be linked to differential impact from innovative teaching and learning (UNESCO 2021). More so, the geographical location of the schools may be important, noting the spatial differences in teacher quality that may further compound the implementation of the innovation (United Nations 2020) and may adversely influence associations with pupils' mental health. This next section ties these issues together, to understand other factors underlying the results.

4.4. Heterogeneity by pupils'/teachers' gender and school location

This section analyses how the location of the school, the gender of the student and instructor, and other factors mediates the relationship between school innovation and students' mental health. Overall, [Table 4](#) demonstrates that, contrary to earlier predictions, the estimated associations does not significantly differ by the gender of the student, with the exception of the likelihood of female students (unlike male students) feeling more angry than usual. This association increases by 9.4 percentage points with school innovation and may be attributable to the fact that girls find it challenging to participate in digital remote learning modalities for a variety of reasons. For instance, a dearth of digital skills, cultural norms that restrict their use of technology, and a greater household workload that interfere with the time they would have spent learning remotely are just a few of the factors (UNESCO 2021; United Nations 2020). Due to these complex difficulties, girls may develop mental health issues, which could account for our finding of negative emotions with school innovation.

[Table 5](#) shows the outcome after mediating the main coefficient with the teacher's gender. The likelihood of social isolation is the only variable where there is a statistically significant difference

Table 4. Mental health outcome by pupil's gender.

	Aggregate mental health score	Felt more lonely than usual	Upset over things that would not have normally bothered me	Felt angry more often than usual	Did not feel like contacting my friends	Was more worried than usual about my friends and family getting sick
	[1]	[2]	[3]	[4]	[5]	[6]
School innovation	-0.628*** (0.158)	-0.161*** (0.056)	-0.143*** (0.054)	-0.175*** (0.056)	-0.010 (0.055)	-0.229*** (0.048)
Pupil's gender (1 if a girl)	0.005 (0.044)	0.005 (0.015)	0.011 (0.015)	-0.011 (0.015)	0.008 (0.015)	-0.007 (0.013)
School innovation × Pupil's gender	0.121 (0.135)	-0.017 (0.047)	0.042 (0.046)	0.094** (0.048)	-0.002 (0.046)	-0.007 (0.041)
Observations	4,653	4,486	4,474	4,447	4,438	4,498
R-squared	0.416	0.343	0.392	0.383	0.364	0.339

Note: All the regressions include the following covariates, principal's age, binary indicator of principal's age, principal's experience in school, principal's gender, school population (total pupils), school ownership (1 if public), teacher's experience (1 if 5 years and above), teacher's age, teacher's age in binary (1 if 30 yrs. and above), teacher's gender (1 if female), and pupil's age. The values in parenthesis are the standard errors, clustered at the school level. The superscript are as follows, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5. Mental health outcomes by teacher's gender.

	Aggregate mental health score	Felt more lonely than usual	Upset over things that would not have normally bothered me	Felt angry more often than usual	Did not feel like contacting my friends	Was more worried than usual about my friends and family getting sick
	[1]	[2]	[3]	[4]	[5]	[6]
School innovation	-0.554*** (0.162)	-0.137** (0.057)	-0.103* (0.056)	-0.121** (0.057)	0.096* (0.056)	-0.271*** (0.049)
Teacher's gender (1 if a girl)	-0.101 (0.086)	-0.038 (0.030)	-0.026 (0.030)	0.010 (0.031)	0.017 (0.030)	-0.083*** (0.026)
School innovation × Teacher's gender	0.004 (0.284)	-0.078 (0.100)	-0.033 (0.099)	0.001 (0.100)	-0.312*** (0.099)	0.111 (0.087)
Observations	4,754	4,580	4,570	4,543	4,532	4,594
R-squared	0.414	0.342	0.386	0.381	0.364	0.334

Note: Similar to [Table 4](#)

between coefficients according to the gender of the class teacher. With regard to the student's affirmative response that they did not feel like calling friends, the result shows a 31.2 percent point significant decline. A final analysis in [Table 6](#) takes into account the schools' locations as a mediating factor. According to the data, schools in towns and cities (areas with a population of 3,000 or more) are the only ones to document improvements in students' emotions as a result of innovative teaching strategies used during the pandemic. The interacting variable is primarily negative and has significant coefficients for the overall measure of mental health, the likelihood of social isolation, and feeling more anxious. Students attending schools in areas, largely rural and with low-income households, do not particularly record better mental well-being for these three metrics. These findings can point to some geographic disparity in the results of the pandemic-related school innovation.

4.5. Other mechanisms

Some probable explanations for the link between school innovation and students' mental health include the fact that students in schools with innovative learning report being in better emotional states as a result of less disruption at school. As seen in [Table A2](#), students' access to technology does not, by itself, improve their mental health because there is no discernible difference in the emotional experiences of students depending on whether they have access to technology at home. Instead, it lowers learning loss through the use of technology. In other words, because school innovation was focused on improving students' learning results, a positive association was shown.

The data source enables the direct assessment of this mechanism by depending on the information about whether there is a drop during the school disruption in the student's capacity to keep up with studies and confidence in finishing studies. These indications are binary, with a value of '1' in the case of a perceived decline by the pupils and '0' in the absence of such perception, with the school closure period serving as the reference point. Evidence from [Table 7's](#) columns 1 and 2 suggest that there has been a significant decline in both likelihood of reporting a decline in students' ability to keep up with their schoolwork and likelihood of reporting a decrease in students' confidence to finish their studies, each by 23.6 percentage points and 19.3 percentage points, respectively.

The availability of support system for students to deal with the lockdown constraints is a potential additional mechanism that could explain how the innovation enhanced mental health results (Balta-Salvador et al. 2021; United Nations 2020). A number of options exist:

Table 6. Mental health outcomes by school location.

	Aggregate mental health score	Felt more lonely than usual	Upset over things that would not have normally bothered me	Felt angry more often than usual	Did not feel like contacting my friends	Was more worried than usual about my friends and family getting sick
	[1]	[2]	[3]	[4]	[5]	[6]
School innovation	-0.005 (0.122)	0.024 (0.042)	-0.087** (0.042)	-0.147*** (0.043)	0.047 (0.041)	0.064* (0.037)
School location (1 if in a town/city)	0.371*** (0.133)	0.089* (0.046)	0.050 (0.046)	-0.046 (0.047)	0.194*** (0.046)	0.096** (0.041)
School innovation × School location	-0.383** (0.165)	-0.035 (0.057)	0.006 (0.057)	0.007 (0.058)	-0.182*** (0.057)	-0.107** (0.050)
Observations	4,436	4,273	4,265	4,239	4,239	4,287
R-squared	0.423	0.357	0.393	0.394	0.375	0.330

Note: Similar to [Table 4](#).

Table 7. Other Mechanisms underlying how school innovation correlates with pupils mental wellbeing.

	Decline in ability to keep up with schoolwork [1]	Decline in confidence in completing schoolwork [2]	Teachers showed interest in pupils' learning during lockdown [3]	Teacher was available when needed for help. [4]	Teacher made special effort to keep in contact. [5]	Teacher adapted schoolwork to meet pupils' individual needs. [6]
School innovation	−0.235*** (0.086)	−0.193** (0.085)	0.130*** (0.042)	0.091** (0.039)	0.082** (0.040)	0.026 (0.041)
Observations	1,974	1,972	1,953	1,953	1,953	1,953
R-squared	0.442	0.442	0.469	0.456	0.416	0.439

Note: All the regressions include the following covariates, principal's age, binary indicator of principal's age, principal's experience in school, principal's gender, school population (total pupils), school ownership (1 if public), teacher's experience (1 if 5 years and above), teacher's age, teacher's age in binary (1 if 30 yrs. and above), teacher's gender (1 if female), and pupil's age. The values in parenthesis are the standard errors, clustered at the school level. The superscript are as follows, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

1. Students whose mental health may be harmed by the lockdown will receive greater care, for instance because the teacher is more likely to be accessible in schools that use innovative teaching methods.
2. Students with special needs in schools lacking innovative learning may need to wait until classes resume in order to make the connections they need, leading to poor mental health as a result.

This mechanism was examined in the study, as students were questioned whether their teachers were readily available when they needed assistance and how much their teachers showed an interest in their academic progress. Understanding teachers' support networks during the Covid-19 lockdown requires answering a different question about whether the teachers made an extra effort to get in touch with the sampled students. Thus, I investigate whether students who attended schools using innovative teaching methods during the period of school closure were more likely to indicate that their teachers provided learning support during the pandemic restrictions.

The findings in columns 3 and 4 of Table 7 indicate that students in schools with learning innovations are significantly more likely to agree that teachers showed interest in their learning during the lockdown (by 13 percentage points) and that the teachers were readily available when assistance was needed (by 9.1-percentage points). More so, column 5 suggests that the sampled pupils in schools with learning innovations are more likely to report that their teachers made a special effort to keep in contact during the lockdown (by 8.2-percentage points). As a result, efforts made by the school to reinvent its teaching strategy to sustain teacher-student interaction even while schools were closed may be responsible for improvements in students' mental health situations.

4.6. Discussion

The purpose of this paper was to examine the relationship between gains in students' mental health and school innovation that guarantees continuous learning experiences during the COVID-19 lockdown. The analysis makes use of a recently released dataset for Burkina Faso and Ethiopia. The data includes details on online (computer-based) and offline approaches (e.g. sending paper materials home, telephone-based teaching), as well as information on innovative school teaching that emphasizes the usage of both – hybrid.

This study's results suggest a plausible relationship between school innovation and students' mental health. The predicted coefficient size is significant when compared to the average overall mental health score of students in schools without a learning innovation. Back-of-the-envelope calculations reveal that students in schools without a learning innovation had an average mental health score of 2.804 units, which would have been decreased by nearly 20% with a school innovation for continuing learning.

The results of this study are compared to other learning innovation interventions' effect as follows. Balta-Salvador et al. (2021) discovered that online learning during the Covid-19 pandemic enhanced students' emotional conditions, but only with stronger connection and communication among students and between students and teachers. An online self-help intervention was conducted by Charbonnier et al. (2022) on university students, and the results showed that the intervention group had less negative emotion—including symptoms of anxiety. On the other hand, several research document negative consequences of comparable innovation for a variety of causes, such as social isolation due to decreased physical connection and attention deficit in virtual classes (Alpert, Couch, and Harmon 2016; Bird, Castleman, and Lohner 2020; Kofoed et al. 2021). This study's estimate is comparable to those arguing for improved mental wellbeing with learning innovation, without prejudice to the opposing set.

The gender of the students, the gender of the teacher, and the location of the school are crucial individual-level factors that influence how well learning innovation affects various indicators of students' mental health for the entire sample. For instance, one of the results indicates a significant difference in the effect of school innovation on the likelihood of feeling angrier, which is strongest for girls compared to boys. In addition, female teachers, as opposed to their male counterparts, saw a reinforcing effect of implementing school innovation on students' likelihood of feeling less alone. The results of this study suggest that there may be a gendering influence in how a particular innovation defines students' mental health during a health pandemic. In light of this study, educational innovation for students' mental well-being must take teachers' gender into account. Additionally, the geographical and structural variations in the regions where schools are located will influence the effectiveness of school innovation. One should not be shocked to learn that this innovation only benefits students who live in towns and cities, as opposed to those who live in villages and communities, in contexts where such a disparity connotes multiple dimensions of inequality. This conclusion is supported by this study's results.

The correlations found in this study can also be explained by the fact that the sampled pupils attended schools with innovative learning practices where there was less disruption to their schooling and where there were support systems in place to cope with the negative psychosocial effects of the Covid-19 lockdown. This research implies that, in addition to the educational goal of schools' innovative practices for continuing education during a health shock, some other downstream consequences to support and ensure students are other pertinent benefits, which result in the improved mental wellbeing of students.

5. Conclusion

Improving children's mental health during a pandemic with massive learning disruption for the most vulnerable children in underdeveloped nations remains a policy-relevant objective, since many children may be affected by this crisis. Before the pandemic, more than half of children in low- and middle-income nations were already living in Learning Poverty, with a possible increase to 70% due to pandemic disruptions (The World Bank, UNESCO, and UNICEF 2021). Furthermore, children in impoverished nations are already cognitively burdened as a result of their exposure to violence, hardship, and other unpleasant childhood events (Harms 2017). As a result, the findings in this research are useful for continuing policy conversations concerning other psychological benefits for children from policies that enable school learning innovation, such as technology-driven and low-cost approaches to ensuring learning continuity.

The results of this study are of non-trivial importance given the prevalence of children's poor mental health conditions in Burkina Faso (58 percent reported emotional violence) and Ethiopia – 23% (Harms 2017; Kamau et al. 2017; Mental Health Innovation Network 2015). On the one hand, the findings of this study imply that these measures can contribute to children's mental wellbeing through ongoing learning and the provision of support systems for pupils during the pandemic. However, they also highlight crucial factors including the gender of the student and teacher, as

well as the physical location of the school, that may affect how much of a positive impact such technology has.

Future research that expands on this study's limitations could look at variation in terms of the innovative efforts school systems take to preserve learning in the face of a shock that stops students from attending class. This understanding is required to separate the consequences of computer-based and non-computer-based innovations. Given the study's low statistical power, this type of analysis proved difficult. Another constraint for future consideration could be the time frame of learners' exposure to such learning approaches. This study implies that exposure to the innovative teaching strategies utilized in schools throughout the pandemic occurred over a consistent time span. In other words, it is unclear how the results apply to a child whose school innovated its teaching approach for a short period, say an academic term, compared to those in schools with a longer implementation period, say two terms or more. Future research using data that describes the length of innovation would increase our understanding of heterogeneity by the various dimensions of the innovation time frame.

Notes

1. Keeping pupils engaged in curriculum-based learning despite lockdowns at schools and disruptions to social interactions.
2. Kenya was not considered for the analysis because there was no reporting of schools' innovative engagement for continuing learning from this study's data source.
3. Burkina Faso – 2,474 pupils, 992 teachers, and 138 schools/principals, while in Ethiopia – 3,621 pupils, 1,719 teachers, and 186 schools/principals.
4. For more information about the sample design, interested readers can access Meinck, Fraillon, and Strietholt (2022).
5. The probability of school selection is proportional to the number of target grade students in the schools.
6. The approach is similar to that used by Adhvaryu, Fenske, and Nyshadham (2019) to compute negative emotions when the sum of the responses to the individual indicators rises.
7. This analysis is available upon request.

Disclosure statement

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Appendices

Table A1. Regression result – Robustness checks.

	Aggregate mental health score	Felt more lonely than usual	Upset over things that would not have normally bothered me	Felt angry more often than usual	Did not feel like contacting my friends	Was more worried than usual about my friends and family getting sick
A. Adjusting for specific household characteristics						
School innovation	−0.529** (0.240)	−0.174*** (0.011)	−0.053 (0.088)	−0.049 (0.089)	−0.108 (0.087)	−0.161*** (0.058)
Observations	3,953	3,822	3,811	3,799	3,793	3,836
R-squared	0.438	0.351	0.399	0.400	0.384	0.348
B. Including additional school characteristics						
School innovation	−0.593*** (0.203)	−0.174** (0.082)	−0.044 (0.085)	−0.141*** (0.008)	−0.063 (0.078)	−0.169*** (0.053)
Observations	4,763	4,580	4,580	4,554	4,549	4,603
R-squared	0.415	0.352	0.352	0.386	0.360	0.332

(Continued)

Table A1. Continued.

	Aggregate mental health score	Felt more lonely than usual	Upset over things that would not have normally bothered me	Felt angry more often than usual	Did not feel like contacting my friends	Was more worried than usual about my friends and family getting sick
C. Adjusting for Schools' Sample Weight						
School innovation	-0.846*** (0.236)	-0.341*** (0.079)	-0.169* (0.095)	-0.205** (0.090)	-0.026 (0.081)	-0.267*** (0.081)
Observations	4,754	4,580	4,570	4,543	4,532	4,594
R-squared	0.492	0.413	0.454	0.454	0.450	0.400
D. Inclusion of Additional Sets of Control						
School innovation	-0.495** (0.215)	-0.223*** (0.081)	-0.017 (0.085)	-0.069 (0.082)	-0.004 (0.076)	-0.182*** (0.060)
Observations	4,622	4,449	4,441	4,419	4,406	4,462
R-squared	0.425	0.349	0.391	0.379	0.378	0.342

Note: All the regressions include the following covariates, principal's age, binary indicator of principal's age, principal's experience in school, principal's gender, school population (total pupils), school ownership (1 if public), teacher's experience (1 if 5 years and above), teacher's age, teacher's age in binary (1 if 30 yrs. and above), teacher's gender (1 if female), pupil's age, and the fixed effect at the country-, school-, and teacher- level. Panel D does not adjust for the country fixed effect so as to preserve the estimates for the Covid-19 stringency. The Covid-19 stringency is an index that records the strictness of 'lockdown style' policies that primarily restrict people's behavior. Higher values imply stricter lockdown policy and vice versa. The values in parenthesis are the standard errors, clustered at the school level. The superscript are as follows, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A2. Access to technology and mental wellbeing.

	Aggregate mental health score	Felt more lonely than usual	Upset over things that would not have normally bothered me	Felt angry more often than usual	Did not feel like contacting my friends	Was more worried than usual about my friends and family getting sick
Access to computers, tablet or smart phones	-0.038 (0.052)	0.014 (0.018)	-0.014 (0.018)	-0.033* (0.018)	-0.026 (0.018)	-0.001 (0.016)
Observations	4,791	4,618	4,610	4,585	4,564	4,633
R-squared	0.413	0.348	0.381	0.389	0.367	0.329

Note: All the regressions include the following covariates, principal's age, binary indicator of principal's age, principal's experience in school, principal's gender, school population (total pupils), school ownership (1 if public), teacher's experience (1 if 5 years and above), teacher's age, teacher's age in binary (1 if 30 yrs. and above), teacher's gender (1 if female), pupil's age, and the fixed effect at the country-, school-, and teacher- level. The values in parenthesis are the standard errors, clustered at the school level. The superscript are as follows, * $p < 0.1$.