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Breaking Barriers: How the Pandemic Bridged the Academic Achievement Gap in Rural and Urban Schools

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The article examines the impact of the COVID-19 pandemic on the dynamics of academic achievement in schools in the Novosibirsk region over the period of 2017—2022. Using data on individual Basic State Examination results of grade 9 students, the study applies multilevel regression modelling to examine the differential impact of the COVID-19 pandemic on urban and rural schools. Contrary to previous studies which predicted that rural students would be most affected, the results were unexpected. When analysing the academic performance of students in the overall sample, no significant differences were found between the years: on average, the pandemic had no effect on academic performance in the region. However, assessing the differential effect according to the type of settlement in which the school was located revealed atypical trends: urban schools experienced a slight decrease in academic achievement after the pandemic, while rural schools experienced an increase. Notably, the year of the pandemic eliminated the achievement gap between urban and rural schools, making it statistically insignificant. Possible explanations for these results could be regional policies to support students or changes in examination procedures. These counterintuitive findings challenge the dominant educational research on COVID-19 and highlight the unexpected role of the pandemic in changing the trajectory of academic achievement.

Keywords: COVID-19 pandemic; Basic State Examination; urban schools; rural schools; educational inequality.

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Преодоление барьеров: как пандемия устранила разрыв в успеваемости в сельских и городских школах

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В статье рассматривается влияние пандемии COVID-19 на динамику успеваемости в школах Новосибирской области в период с 2017 по 2022 годы. С использованием данных индивидуальных результатов ОГЭ учащихся 9-х классов в исследовании применяется многоуровневое регрессионное моделирование для изучения дифференцированного влияния пандемии COVID-19 на городские и сельские школы. Вопреки предыдущим исследованиям, которые предсказывали, что больше всего пострадают сельские школьники, полученные результаты оказались неожиданными. При анализе академических достижений учащихся на общей выборке значимых различий между годами не обнаружено: пандемия в среднем никак не отразилась на успеваемости в регионе. Однако оценка дифференцированного эффекта в зависимости от типа населенного пункта, в котором находится школа, выявила нетипичные тенденции: в городских школах после пандемии наблюдалось небольшое снижение успеваемости, а в сельских школах, наоборот, повышение. Примечательно, что год пандемии за счет этого устранил разрыв в успеваемости между городскими и сельскими школами, сделав его статистически незначимым. Возможными объяснениями полученных результатов могут быть региональные меры, принятые для поддержки школьников, или изменение процедуры проведения экзаменов. Эти контринтуитивные результаты опровергают доминирующие исследования в области образования, посвященные COVID-19, и подчеркивают неожиданную роль пандемии в изменении траекторий академической успеваемости.

Ключевые слова: пандемия COVID-19; ОГЭ; городские школы; сельские школы; образовательное неравенство.

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Introduction

The COVID-19 pandemic has undoubtedly had a profound impact on education systems around the world, fundamentally changing the way we think about the organization of the educational process. Schools and universities in most countries have faced enormous challenges in dealing not only with the immediate health risks to students, but also with the far-reaching economic and social consequences of the pandemic [Hanushek, Woessmann, 2020]. The impact of the global disruption to education — which lasted an average of 10 weeks [Schleicher, 2020] — is being widely discussed by academics and policymakers alike.

Today, three years after the start of the pandemic, meta-analyses that systematize the results of empirical work to assess the impact of the pandemic on the quality of education in different countries are becoming increasingly common. One of the first meta-analyses found that the pandemic led to a small decline in student outcomes, on average 0.10SD [Hammerstein et al., 2021]. In the most recent meta-analytic study, the loss estimate was slightly higher at 0.14SD [Betthäuser, Bach-Mortensen, Engzell, 2023]. However, if more stringent criteria is applied to the selection of studies in the meta-analysis, the loss size increases to 0.18 SD [König, Frey, 2022], which is close to the medium effect size. Thus, at this point, we can confidently conclude that the COVID-19 pandemic has, on average, resulted in a substantial decline in the performance of school children equivalent to at least one third of a school year [Hattie, 2015]. It is important to note that the decline in achievement that occurred during the pandemic has not disappeared over time, despite the best efforts of the education system to compensate for it [Betthäuser, Bach-Mortensen, Engzell, 2023].

The crisis disproportionately affected the most vulnerable groups of learners in the education system, as became evident during the pandemic. Research confirms that the greatest learning losses were experienced by students in lower grades [K nig, Frey, 2022], from families with a low socio-economic status [Betth user, Bach-Mortensen, Engzell, 2023] and with low academic achievement [Grewenig et al., 2021]. One of the reasons for the sharpest decline in achievement in these groups is the reallocation of children's study time to activities that do not contribute to academic achievement, such as watching television or playing computer games [Grewenig et al, 2021]. At the same time, the low levels of parental and school support that characterize those in disadvantaged circumstances [Prakhov, Kotomina, Sazhina, 2020; Maag Merki et al., 2020] did not compensate for the reduction of time spent on learning [Grewenig et al, 2021]. Interestingly, much less research attention has been paid to assessing differences in the impact of the pandemic between urban and rural students, the latter being among the most vulnerable categories of students [The United Nations, 2020]. However, it is known from studies on the impact of COVID-19 on different types of schools that rural schools are poorly equipped and therefore unprepared for distance learning [Tadesse, Muluye, 2020; Zvyagintsev, Kersha, Pinskaya, 2020].

Despite active research on the impact of the pandemic on education around the world, there are not many works devoted to this topic in the context of the Russian educational system. Only one Russian study empirically assessed the impact of the pandemic on students' knowledge levels using objective test data [Chaban et al., 2022]. According to its results, significant losses in academic performance were only observed among 8th grade students in the subject of science. It is noteworthy that, despite the confirmation of the trend of increasing inequality during the pandemic period by foreign studies, in the Russian sample all

students experienced the same decline in achievement, regardless of the socio-economic status of their families. Other works in the Russian context compare the achieved and expected USE scores of students using a self-report survey [Yakobyuk, 2020], study the features of the transition to distance learning [Saprykina, Volokhovich, 2020], the well-being of teachers [Petrakova, Kanonir, Kulikova, 2021] and other aspects of the educational process during the pandemic, without attempting to make an objective assessment of the losses during this period.

In order to fill the aforementioned gaps in scientific literature, the present study aims to quantify the changes in the academic performance of students in urban and rural areas before and after the pandemic, using data from the BSE in Russian language and Mathematics. Using the example of one Russian region, the Novosibirsk Oblast, we will attempt to answer two research questions:

1. How did students' BSE results change before and after the COVID-19 pandemic?

2. Are the effects of the pandemic different for rural and urban schools in the region?

Study background

In the Novosibirsk region, the education system is facing new difficulties due to the pandemic that started in spring 2020. Schools in the region were forced to completely change their work due to the introduction of restrictive measures caused by the threat of COVID-19. Depending on the technical conditions of the school and the possibilities of the families, education was organized according to one of three models, chosen by the schools themselves[1].

The first model was used by schools with good technical conditions. The implementation of the educational program was carried out entirely in the distance mode, using the regional distance learning system and freely available digital educational platforms and resources. The second model was recommended for schools with insufficient internet speed for working with distance learning systems and conducting classes in real time. All materials prepared for the educational program, including homework, were sent by the teacher to the students via e-mail, file sharing, social networks, chat rooms, forums or delivered face-to-face by the class teacher (according to a fixed schedule of school visits, for example once or twice a week). Both pupils and their parents could receive tasks. Feedback from teachers was given to students in the same way. The third model involved the face-to-face teaching of students in separate rooms of the school and in small groups of up to 12 students. This model was mainly used in rural schools.

To organize work during the pandemic in the Novosibirsk region — as in other regions of Russia — recommendations were developed for students, their parents, teachers and educational organizations. These included: the strengthening of sanitary and epidemic control measures in schools; methodological recommendations for implementing educational programs using e-learning and distance learning technologies; leaflets for parents and other participants in the educational process; and local laws on distance learning in schools. In order to provide methodological support to school teachers, webinars were also held on the use of educational platforms for organizing distance learning (such as the Russian Electronic School (RES), Skyes School, YaClass, Uchi.ru, Mobile Electronic Education (MEO), Yandex Tutor, Yandex Textbook, etc.) the resources for sharing

[1] In accordance with the Letter of the Minister of Education of the Novosibirsk Region dated 27 March 2020 No. 2952-03/25 "On the Work of Educational Organizations Under Restrictive Measures".

educational information (regional distance learning system (RDLS), GIS "Electronic School", Yandex Connect (Yandex service for organizing teamwork in the cloud), videoconferencing resource (VVR), Wiki, etc.).

In order to coordinate the work to support the educational process during the pandemic, the Ministry of Education of the Novosibirsk region organized a headquarters — the Single Channel of Communication, which gathered information from all hotlines. The center operated in a "one-stop-shop" mode, providing comprehensive information on all issues to both heads of educational organizations and parents in a 24/7 mode with no restrictions on work hours. Targeted support was also provided through social networks. The "Pedagogical Volunteer" project was organized at the headquarters: schools received targeted on-site support on request, including additional training for teachers in the organization of the educational process in a distance format. During the period of "self-isolation", television resources were also used: for example, video lessons on various subjects were organized.

As part of the regional "Network of Distance Schools" project (implemented in the region since 2011), each municipality has already gained experience in organizing distance learning for pupils. Nevertheless, all participants in the educational process faced a number of problems and difficulties. According to the results of a questionnaire survey conducted in May 2020 among 518 school teachers, the main problems during this period were: a decrease in the quality of education and the quality of knowledge of schoolchildren (24.9%), difficulties in organizing the educational process in a distance format (23.0%), and an increase in the workload of all participants of the educational process (20.8%). The uncertainty of the situation, the attitude of students and their parents towards distance learning, the work of educational platforms, the lack of control over the education of difficult children, the objectivity of marking in the subject (31.3% in total) also caused concerns.

Since the 13th of April 2020, schools located in territories of the region with a population of less than 23,000 people returned to work in the normal mode, which implied full-time classes in compliance with sanitary and epidemiological requirements. At the same time, other schools in the region operated under special conditions until the end of the 2019—2020 school year. In the next school year, 2020—2021, the epidemiological situation also affected the learning process in schools. From the 16th of November 2020 (after autumn break), pupils in grades 1—5, 11 and small schools started face-to-face studies. Students in grades 6 to 10 switched once again to distance learning. Only on the 11th of December 2020 did all students return to face-to-face education.

The features of the pandemic assessment procedures were adopted at the federal level and affected all Russian regions. In 2020, for the first time, the Basic State Examination in 9th grade (hereinafter — BSE) was held in the form of an intermediate examination, the results of which were recognized as BSE results. The arithmetic mean of the quarter (trimester) grades for grade 9 in all subjects of the curriculum was used as the basis for issuing certificates of basic general education.

At the federal level, it was decided to conduct additional monitoring of the quality of education in the autumn of 2020 in the form of the diagnostics tests in grade 10 based on the BSE test materials. These tests were carried out in three subjects: Russian language and Mathematics as compulsory subjects, and one subject according to the student's learning profile and choice. The diagnostic works were checked by experts of the regional subject commission. The main difference between the procedure for carrying out diagnostic

work and BSE was that the diagnostic work was carried out in schools rather than in examination centers, which casts doubt on the objectivity of the results obtained due to the quality of the observation of students. In 2021, 9th graders took the BSE in Russian language and Mathematics already in the standard form, and, in the case of the subject of their choice, they wrote control papers. Therefore, for the most objective comparison of students' academic performance in this period, it is worth using only data from compulsory subjects: Russian language and Mathematics.

Method

This study applied a multilevel regression modelling approach [Hox, 2017] to assess the impact of the COVID-19 pandemic on the academic performance of students. The analysis was conducted using a three-level data structure, including students' exam results at the first level, exam year at the second level, and educational institutions at the third level.

Sample. The final sample for the analysis after data preparation included 512 schools in the Novosibirsk region and a total of 113,962 students who took the BSE in Russian language and Mathematics between 2017 and 2022, as well as diagnostic tests based on BSE materials in 2020. The database included the results of all students from the participating schools who took the exam at the end of 9th grade.

Variables. The database contained variables at the student and school level. For each participant, the percentage of exam performance in Russian and Mathematics (0—100%) was calculated by dividing the raw score obtained by the maximum possible score for the exam in the current year. Exam results were available for six years: for cohorts of students who took the exam in 2017—2022. Descriptive statistics on the average exam results of children in the region are presented in Appendix 1 (Table 1).

The following variables, available from 2017 to 2021, have been included in the database in the school level:

- Proportion of learners with special needs (with disabilities, children with disabilities)
- Proportion of pupils with at least one unemployed parent
- Proportion of pupils whose parents have not completed tertiary education
- Proportion of students from single-parent families
- Proportion of students from large families
- Proportion of students from low-income families

Each of the variables listed was averaged across educational institutions for the five years and used in the analysis as an indicator characterizing the school composition for the entire study period. Descriptive statistics on the average characteristics of schools in the region are presented in Appendix 1 (Table 2). In addition, the database recorded the location of the educational institution in 2023 — urban (46% of schools) or rural (54% of schools).

Data analysis strategy. In the database preparation stage, Tukey's statistical outlier search method [Tukey, 1977] was used for all quantitative variables. Indicators that were atypically high or low for the sample, such as the proportion of different groups of students in the school and examination results, were excluded from the database. In addition, educational institutions whose changes in enrollment over the study period were within the range of atypical values for the sample were excluded from the analysis. For the remaining observations, quantitative variables were standardized prior to inclusion in the analysis model. In the case of the examination results, standardization was carried out within each subject and year.

To assess the impact of the pandemic on the academic performance of 9th grade

students, a multilevel fixed slope random intercept growth model [Hox, 2017] was used to track changes in examination results from year to year over six years. The reference year used was 2020, the year of the pandemic after a break in full-time education. Separate models were fitted for each subject — Mathematics and Russian language — with exam results as the dependent variable. School characteristics and the year of examination were included as covariates in the model. Before including the covariates in the model, multicollinearity was assessed by estimating the VIF score [Fox, 2016]. As no multicollinearity problems were found, the full set of independent variables listed above was used in the analyses.

A total of two regression models were fitted for each subject area: a model to estimate the overall effect of the pandemic without including the interaction variable (Model 1), and a model to estimate the differential effects for rural and urban areas, including the interaction variable between settlement type and examination year (Model 2). To facilitate the interpretation of the results based on Model 2, plots of predicted exam results for each year were constructed separately for rural and urban schools, describing the interaction effect between the variables. Statistical analysis was performed using R Studio version 1.1.456.

Results

The results of the regression analysis, presented in detail in Appendix 2, show that, on average, the academic performance of the region's graduates did not change significantly over the study period (Model 1). In Russian, the average percentage of BSE performance during the pandemic period and after (2020-2022) is not statistically significantly different from the previous years. In Mathematics, there is a statistically significant decrease in BSE scores after the pandemic at the $p<0.05$ level, but the magnitude is so small that it is difficult to interpret this as a worsening of the situation. Thus, on average, the COVID-19 pandemic did not lead to changes in the academic performance of students in Novosibirsk Region.

However, when the model includes the interaction variable between the year of the exam and the type of settlement in which the educational institution is located, the situation changes dramatically. The figures below show the predicted BSE scores in Russian language and Mathematics from 2017 to 2022, separately for urban and rural schools. The absence of a decline in academic performance in the overall sample hides a rather unexpected trend: after the start of the pandemic, exam scores declined in urban schools, while they increased in rural schools. Although these changes are not statistically significant compared to previous periods of the study — for each of the groups separately, the new average scores are within the confidence interval of the scores of previous years — they are likely to have offset the change in results during the pandemic in the overall sample for the region, compensating for each other. At the same time, it is safe to conclude that the changes that occurred in the pandemic year led to the disappearance of the academic achievement gap between urban and rural educational institutions that had persisted in all the years before the pandemic. After the pandemic, urban and rural schools performed equally well on average in exams, controlling for differences in student populations.

It is also worth noting that the changes in exam results after the pandemic in Russian and Mathematics are slightly different. In the case of Russian, the main increase in rural schools' results occurred in the year of the pandemic. Compared to 2019, graduates from rural schools improved their results by more than 0.1 SD in 2020. In the following years, there are slight fluctuations in BSE scores, but in general the level achieved during the pandemic is

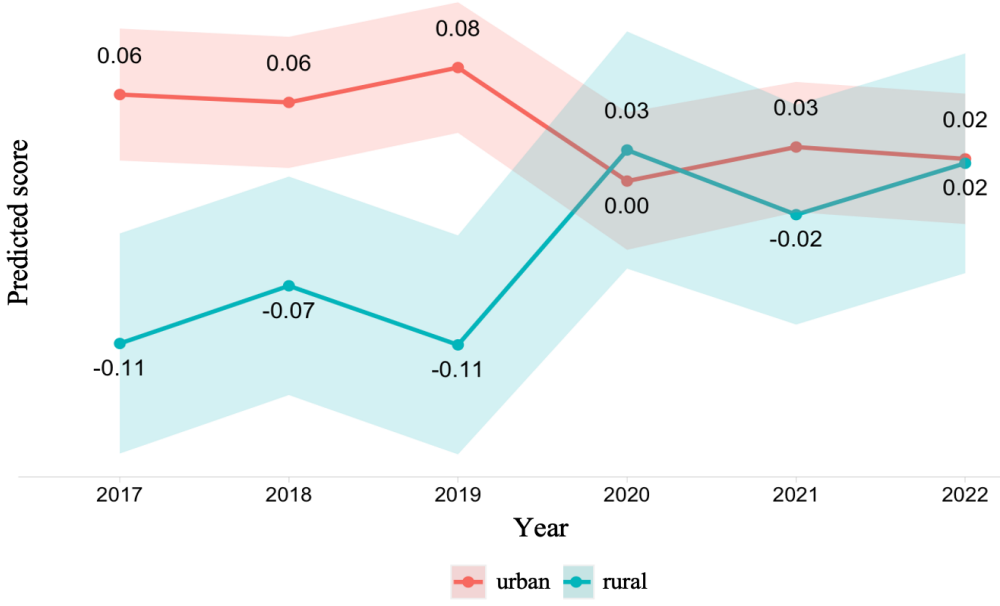

Figure 1. Predicted standardized BSE scores in Russian for urban and rural schools, based on the results of the regression analysis (2017—2022)

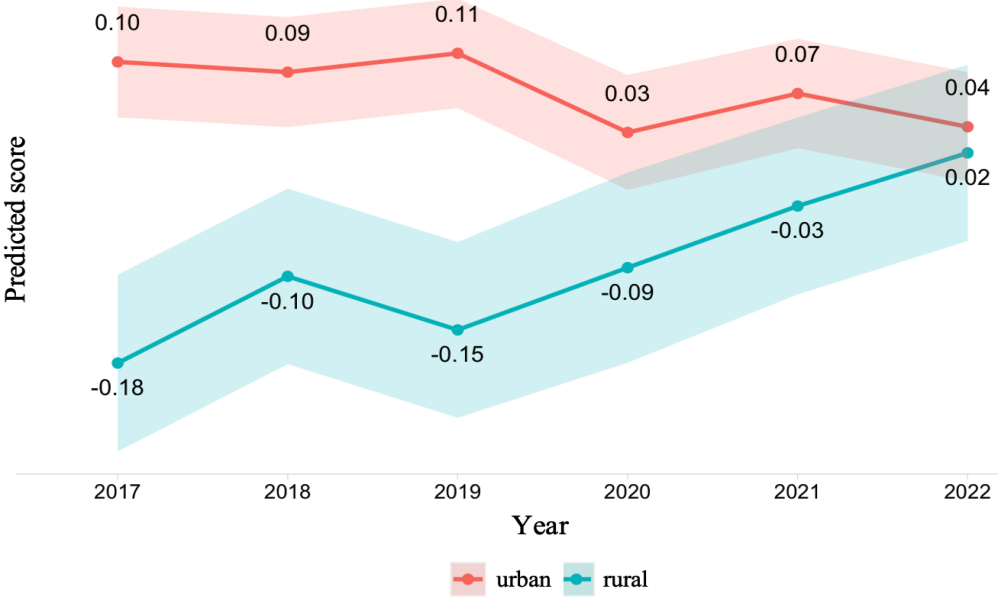

Figure 2. Predicted standardized BSE score in Mathematics for urban and rural schools based on the results of regression analysis (2017—2022)

maintained. At the same time, the decline in results in urban schools is quite significant in the year of the pandemic and does not change much thereafter. In Mathematics, on the other hand, rural students' scores increase fairly evenly from the year of the pandemic and continue to rise gradually. For urban schools, the situation is similar to the Russian language test: after a dip in 2020, the average score remains at about the same level in other years.

Conclusion

Key Results:

• On average, the COVID-19 pandemic had no impact on the academic performance of students in the region.

• The data revealed an unexpected pattern: student test scores during and after the pandemic increased in rural schools and decreased in urban schools. This led to a statistically significant decrease in the gap between the two groups of schools, which persisted after the pandemic.

• In Russian, the post-pandemic increase in scores was greater in rural schools and did not lead to a further increase in scores. In Mathematics, on the other hand, graduates from rural schools steadily increased their BSE scores in all years after the pandemic.

• Urban schools do not show a return to the pre-pandemic levels of BSE performance in both subjects until 2022, although the decline in their results is generally not statistically significant.

Limitations

First of all, one of the limitations of the research conducted, which should be taken into account when interpreting the results, is the lack of precise information in the models about the duration of the presence of schools in the distance mode of operation. Taking into account the conditions of the organization of the educational process in the Novosibirsk Region, this does not currently allow to reliably explain the differences found between urban and rural schools. Since schools in municipalities with a small number of pupils were subject to early entry into the face-to-face mode of education, 85% of all rural schools in the region were among them. This means that more than half of the rural schools were in distance learning for no more than two weeks. At the same time, not a single urban school in 2020 switched to the face-to-face mode before the start of the next academic year. Therefore, in addition to the type of settlement itself, one of the fundamental differences between urban and rural schools is the length of time spent in distance learning, which could be the reason for the different dynamics of results observed in these groups of schools. However, this hypothesis requires additional data and further research.

Secondly, we should not forget that the BSE exams in the pandemic year were very different from the standard format for all regions of Russia. The cancellation of official state exams led to schools carrying out diagnostic work on their own, based on state exam materials, without the control of the state exam commission, which is usually necessarily involved in the conduct of exams. This change may have particularly affected small rural schools, whose scores increased not because of a real improvement in students' preparation, but because the objectivity of the process was not fully ensured. However, it is beyond the scope of this study to test this hypothesis. Furthermore, we should not forget that, in addition to the procedure, the content of the exams themselves may have changed in 2020 due to the situation of the crisis. All of this limits the objectivity of the comparison of examinations from one year to the next.

Thirdly, among the limitations, it is worth highlighting the fact that individual student data — such as gender and the socio-economic status of students' families — were

unfortunately not available to us in this study. Additional information included as covariates in the models was only available at the school level. As a result, the models included in the study show a rather low percentage of explained variance in BSE scores at the first level, where individual characteristics are the most important. It is likely that if this data had been available, the results of the statistical analysis might have been quite different.

Fourth, it is also important to note the weaknesses of the design used in the paper. The approach used to analyze the research data is neither experimental nor quasi-experimental. Although in the case of the pandemic we are indeed observing the situation of a natural experiment, with the emergence of an external factor that ensures that children are divided into those who are affected and those who are not, the method of analysis used does not allow for us to draw conclusions about causal relationships with regard to the effect of the pandemic on the academic performance of students in the region. More advanced techniques, such as regression discontinuity design, require a longer period of observation of students' academic performance. It is possible that this approach could be used in future studies if student performance could be tracked for at least 5 years after the pandemic.

Discussion

In general, the data obtained in the study shows rather unexpected results when it comes to assessing the impact of the pandemic on students' academic performance. Firstly, the fact that the pandemic had no effect on the quality of the results of the Basic State Examination on average is a rather rare case in the context of foreign studies. The absence of negative effects of the pandemic on the quality of education is only noted in a few publications. For example, in a study of the reading and Mathematics skills of younger secondary school students in Sweden who remained in full-time education during the pandemic [Hallin et al, 2022]. In Denmark, where high school students were out of full-time education for 22 weeks, there was very little loss in reading test scores by 2021 [Birkelund, Karlson, 2023]. There was also no post-pandemic decline in student test scores among primary school students in Switzerland [Tomasik, Helbling, Moser,2021] and among primary school students in Australia [Miller, Fray, Gore,2023].

Second, the results of this work completely contradict the predictions that students from the most vulnerable groups, including those in rural schools, will be the most affected during a pandemic [The United Nations, 2020]. In fact, most of the research to date confirms this prediction, showing, for example, that those from families with low socioeconomic status lose more learning opportunities during a pandemic than other groups [Betthäuser, Bach-Mortensen, Engzell, 2023]. Evidence on the differential impact of the pandemic on urban and rural students is less clear, as very few studies compare the academic performance of these groups of students. For example, Colombia in 2020 documented an increase in the inequality between urban and rural schools. The study found that the gap in test scores between urban and rural schools increased by 372.3% in favor of the former [Llanes et al., 2023]. Just one year later, however, the situation had stabilized and inequality indicators had fallen significantly. A McKinsey study of primary school students in the United States, on the other hand, shows that during the pandemic, students in urban schools lost one month more in educational quality than students in rural schools[2]. This is the only study to find similar patterns of achievement among urban students to those found in this study.

It is also noteworthy that students in rural schools in the Novosibirsk Region not only did not suffer from the coronavirus pan-

demic, but also improved their BSE scores from 2020 onwards. In other studies, the increase in performance during the pandemic was most common among students in lower grades. In a study using data from students in Denmark, in addition to no significant losses among high school students, there were gains in reading and mathematics among younger students [Birkelund, Karlson,2023]. In the Netherlands, the extensive use of computer systems for learning has also accelerated the growth of primary school students in mathematics, which has continued after the pandemic [Meeter, 2021]. But the most curious case of score growth during the pandemic is described in the Australian education system. There, the increase in scores among primary school children was only observed among those in disadvantaged schools — the children who were predicted to suffer most from the pandemic. Students in other types of schools showed no change in test scores in response to the pandemic [Miller, Fray, Gore,2023].

When discussing the reasons that may lie behind the results of the paper, several factors should be considered. First, we should not forget the limitations of the current study, which may have influenced the fact that the results contradict the conclusions of most other studies. We mentioned earlier that the change in the format of the exam in 2020 could have affected students' scores for a number of reasons. However, if this was the case, the situation should have returned to normal once the standard exam format was reinstated in 2021 and 2022, which we do not observe in the study data. Second, as an alternative explanation, it is clear that the different duration of distance learning between urban and rural schools could have played a role. A longer duration of distance learning for urban students could be the reason for the decrease in their BSE scores, although insignificant. In addition, as noted above, the average scores for urban schools remained the same after the pandemic and showed no signs of growth in subsequent years.

Nevertheless, it is very unlikely that the fact that rural pupils spend less time in the distance mode fully explains the reduction in inequality between urban and rural pupils. According to the survey data, not only is there no decrease in scores for this group of children, but there is even a slight increase in scores (0.1SD), although this is not statistically significant compared to previous periods. This is unlikely to be due solely to the lack of a learning mode for this group of pupils, which negatively affected the results of the other children. Targeted support to schools and students during the pandemic may have been a plausible mechanism for the improved performance of rural students. A similar hypothesis in a study showing increased achievement during the pandemic in disadvantaged schools [Miller, Fray, Gore,2023] is based on the assumption that fears about the potential negative effects of the pandemic led to unprecedented government attention to a group of the most vulnerable students. It is likely that at least some of the initiatives introduced in Novosibirsk Region during the pandemic and maintained after the pandemic ended contributed to improving the quality of education in rural schools. However, this conclusion is presented in this paper only as a hypothesis, which requires a further investigation of the practices used in the region during and after the pandemic and their interrelationships with the quality of student learning.

In conclusion, the results of this study challenge the assumptions of international

[2] https://www.mckinsey.com/industries/education/our-insights/covid-19-and-education-the-lingering-effects-of-unfinished-learning. Retrieved on: 21.07.2023.

research regarding the impact of the pandemic on widening educational inequalities. The unexpected narrowing of the achievement gap between urban and rural students found in the study may be due to the limitations of the study, the varying duration of distance learning, and the successful support provided to rural schools in the region. All of these factors highlight the complexity of the educational landscape during a pandemic and the importance of taking into account local contexts and specific educational policies when assessing the impact of crises on student achievement.

Appendix 1

Descriptive statistics for the variables used in the analysis

Table 1

Descriptive Statistics of BSE Results in Mathematics and Russian language from 2017 to 2022

Year	N	Mean	St. dev	Min	Max
Русский язык					
2017	18029	80	14	38	100
2018	19759	78	15	33	100
2019	20868	82	13	44	100
2020	11023	73	14	30	100
2021	21317	76	13	39	100
2022	21094	77	12	39	100
Математика					
2017	17656	54	14	16	91
2018	19537	54	17	9	94
2019	20892	55	17	9	94
2020	10896	44	19	0	97
2021	20744	46	13	10	81
2022	21461	44	16	0	87

Table 2

Descriptive Statistics for School Level Variables Averaged Over 2017—2021

Variable	Mean	St. dev.	Min	Max
Proportion of learners with special needs (with disabilities, children with disabilities)	5.2%	4.2%	0%	21%
Proportion of pupils with at least one unemployed parent	12%	13%	0%	58%
Proportion of pupils whose parents have not completed tertiary education	54%	31%	0%	99%
Proportion of students from single-parent families	21%	7.3%	0%	44%
Proportion of students from large families	23%	12%	2.6%	62%
Proportion of students from low-income families	16%	17%	0%	88%

Приложение 2

Результаты применения многоуровневой регрессионной модели роста для оценки изменения академических достижений учащихся до и после пандемии

Таблица 1

Русский язык

	Модель 1			**Модель 2**		
Predictors	**Estimates**	**CI**	**p**	**Estimates**	**CI**	**p**
(Intercept)	–0.17	–0.24 — –0.11	**<0.001**	–0.20	–0.27 — –0.14	**<0.001**
year [2017]	0.00	–0.03 — 0.03	0.959	0.06	0.02 — 0.10	**0.003**
year [2018]	0.01	–0.02 — 0.04	0.518	0.05	0.02 — 0.09	**0.006**
year [2019]	0.01	–0.02 — 0.05	0.426	0.08	0.04 — 0.12	**<0.001**
year [2021]	0.01	–0.03 — 0.04	0.668	0.02	–0.01 — 0.06	0.231
year [2022]	0.01	–0.02 — 0.05	0.415	0.02	–0.02 — 0.05	0.435
ses4 std	–0.03	–0.07 — 0.00	0.076	–0.03	–0.07 — 0.00	0.074
ses7 std	0.02	–0.02 — 0.06	0.357	0.02	–0.02 — 0.06	0.357
ses8 std	–0.19	–0.24 — –0.15	**<0.001**	–0.19	–0.24 — –0.14	**<0.001**
ses10 std	–0.01	–0.04 — 0.02	0.590	–0.01	–0.04 — 0.02	0.559
ses11 std	–0.02	–0.07 — 0.02	0.357	–0.02	–0.07 — 0.03	0.382
ses13 std	0.01	–0.04 — 0.05	0.804	0.01	–0.04 — 0.05	0.817
location [село]	–0.09	–0.17 — –0.01	**0.028**	0.02	–0.08 — 0.12	0.668
year [2017] × location [село]				–0.19	–0.26 — –0.12	**<0.001**
year [2018] × location [село]				–0.15	–0.22 — –0.08	**<0.001**
year [2019] × location [село]				–0.21	–0.28 — –0.14	**<0.001**
year [2021] × location [село]				–0.07	–0.14 — 0.00	0.061
year [2022] × location [село]				–0.02	–0.09 — 0.05	0.500
Random Effects						
σ^2	0.81			0.81		
τ_{00}	$0.03_{\text{year:schl\_id}}$			$0.02_{\text{year:schl\_id}}$		
	$0.08_{\text{schl\_id}}$			$0.08_{\text{schl\_id}}$		
ICC	0.027 (year:schl_id)			0.026 (year:schl_id)		
	0.088 (schl_id)			0.089 (schl_id)		
N	6_{year}			6_{year}		
	$512_{\text{schl\_id}}$			$512_{\text{schl\_id}}$		
Observations	112090			112090		
Marginal R^2 / Conditional R^2	0.042 / 0.152			0.043 / 0.153		
AIC	297727.073			297694.057		
AICc	297727.078			297694.065		
log-Likelihood	–148847.537			–148826.029		

Таблица 2

Математика

	Модель 1			Модель 2		
Predictors	**Estimates**	**CI**	**p**	**Estimates**	**CI**	**p**
(Intercept)	–0.14	–0.21 — –0.07	**<0.001**	–0.15	–0.22 — –0.08	<0.001
year [2017]	0.01	–0.03 — 0.05	0.676	0.06	0.02 — 0.11	**0.008**
year [2018]	0.03	–0.01 — 0.07	0.095	0.05	0.01 — 0.10	**0.023**
year [2019]	0.02	–0.01 — 0.06	0.204	0.07	0.02 — 0.12	**0.003**
year [2021]	0.05	0.01 — 0.08	**0.022**	0.04	–0.01 — 0.08	0.139
year [2022]	0.04	0.01 — 0.08	**0.022**	0.01	–0.04 — 0.05	0.829
ses4 std	–0.04	–0.08 — –0.01	**0.020**	–0.04	–0.08 — –0.01	**0.020**
ses7 std	0.01	–0.04 — 0.05	0.758	0.01	–0.04 — 0.05	0.764
ses8 std	–0.20	–0.25 — –0.15	**<0.001**	–0.20	–0.25 — –0.15	**<0.001**
ses10 std	–0.04	–0.07 — –0.00	**0.033**	–0.04	–0.08 — –0.00	**0.030**
ses11 std	0.01	–0.04 — 0.06	0.700	0.01	–0.04 — 0.06	0.678
ses13 std	0.04	–0.00 — 0.09	0.081	0.04	–0.01 — 0.09	0.082
location [село]	–0.16	–0.25 — –0.07	**<0.001**	–0.12	–0.23 — –0.02	**0.021**
year [2017] × location [село]				–0.15	–0.23 — –0.07	**<0.001**
year [2018] × location [село]				–0.06	–0.14 — 0.02	0.129
year [2019] × location [село]				–0.13	–0.21 — –0.05	**0.002**
year [2021] × location [село]				0.02	–0.06 — 0.10	0.620
year [2022] × location [село]				0.10	0.02 — 0.18	**0.016**
Random Effects						
σ^2	0.78			0.78		
τ_{00}	$0.05_{\text{year:schl\_id}}$			$0.05_{\text{year:schl\_id}}$		
	$0.09_{\text{schl\_id}}$			$0.09_{\text{schl\_id}}$		
ICC	0.051 (year:schl_id)			0.049 (year:schl_id)		
	0.095 (schl_id)			0.096 (schl_id)		
N	6_{year}			6_{year}		
	$512_{\text{schl\_id}}$			$512_{\text{schl\_id}}$		
Observations	111186			111186		
Marginal R^2 / Conditional R^2	0.052 / 0.191			0.054 / 0.191		
AIC	292273.937			292244.322		
AICc	292273.942			292244.330		
log-Likelihood	–146120.969			–146101.161		

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