



# Statistical Analysis of Covid Impact on Education in North America

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**Abstract.** The Covid-19 pandemic since 2019 has affected various aspects of the world like economic and finance. But the utmost loss that the people would face is related to the education sector. Any country, big or small, but if its educational system is good and according to the world standard then it is destined to make progress. Besides, the Covid-19 epidemic has inevitably resulted in an increase in the usage of digital technology which based on the huge statistics data. Statistics has proven its worth in every field, and easily convey numerical details. It's also a representation of mathematical research that utilizes various quantitative models to deliver a batch of empirical data or examinations of naturalistic life. This study discusses the statistics data related to Covid-19. Specifically, in the education part, decision tree algorithms model in machine learning were used to predict the school closures level in North America countries (USA and CAN). Since the lockdown, the parents seemed very concerned over school closure and the education sector faced a major drawback. The result of this analysis indicates that impact of the epidemic on schools is gradually getting better.

**Keywords:** Covid-19 · North America · Statistical Analysis · Decision tree model · School

## 1 Introduction

During the COVID-19 pandemic, the working dataset from COVID-19 patients is critical to comprehend the headway, possible therapy effects, and desired results. Considerable methodological papers have revealed that satisfactory statistical measures are required to predict the future values from the current data Set. Trends in science and technology have seen a sudden positive rise during and after the pandemic [1]. Statistics has proven its worth in every field. Statistics easily convey numerical details and is a domain of mathematics that normally haggles with the display of data, calculations, and understanding of numerical analysis. The statistic is a representation of mathematical research that utilizes various quantitative models to deliver a batch of empirical data or examinations of naturalistic life. Statistics may be described as numerical validities that are sequentially collected.

Statistical Analysis today has reached heights in terms of its importance. It has made its place in every industry, ranging from Engineering and Manufacturing industry to the

domain of Medical Health and sciences. As a matter of fact, as of today, steadfast and valid statistical software is the most vital means known to statisticians in all domains [2].

Technology along with its Statistic facet has proved its worth in difficult times and has emerged as a life saviour for many of us through its analysis capabilities. With this, we can easily analyse and predict everything around us by collecting the statistical data. Designing code that utilizes easy to use interface and adequately complicated code line so it could not be reengineered easily, is a difficult and demanding job. Alongside, the indulgence of statistics has emerged to create numerous opportunities for the statistician specially when simplifying details about educational institutes. Opportunities in the statistics occupation comprise “software design and development, software testing, quality assurance, technical support, education, documentation, marketing, and sales” [3].

## 2 Literature Review

Beginning in 2020, the whole world will be hit by an outbreak of 2019 coronavirus disease, forcing schools worldwide to close and rely on online learning. According to UNESCO, educational institutions in 186 nations will collapse by the end of April 2020, affecting over 74% of registered students globally [4]. Due to the severity of the 2019 coronavirus illness outbreak, several nations have shuttered their schools since March 2020, others since February 2020, and other countries, particularly China, have stopped face-to-face sessions since January 2020. This has a significant influence on student learning outcomes, staff development, training, research, and education.

According to König and Frey [5], the main problem in spring 2020 is the closure of the first schools associated with COVID-19 and the abrupt change from in-person learning to more or less systematic distance learning measures for students, instructors, schools, and parents. The researchers also caution that this abrupt transition might have a detrimental impact on overall student accomplishment and increase achievement disparity. The empirical study explored variations in student academic success before and after confinement based on these early assumptions. The impact of COVID-19-related school closures on student attainment in the spring of 2020 was demonstrated in this study. It also implies that younger pupils are affected more badly than older ones. Second, compared to children from high-income households, children from low-income families were more significantly impacted. Third, systematic distant learning measures, such as online learning programs, assist low-performing students more than high-performing students [5]. Overall, this meta-analysis confirms earlier research on the harmful effects of COVID-19-related school closures have a significant influence on student achievement. The findings are encouraging, as the relationship between distance learning and poor learning outcomes does not appear to be static. In comparison to spring 2020, distance learning looks to be more successful in the later stages of the lockout, and the adoption of proven online learning apps can even boost achievement over traditional face-to-face education.

Furthermore, a study for India found that these measures inevitably affect the country’s economic activities, particularly educational institutions, which are the continent’s

primary source of human capital, and that the people of African countries lack the multiple competencies required to work from home, even if the government lacks the understanding and human resources required to work from home and contribute effectively and efficiently [6]. According to research, this has been demonstrated to affect online learning results in Africa and staff development and training. Acute stress disorders, inadequate control of psychological stresses, mental health difficulties, and sorrow are more common in children who are isolated or confined during a pandemic. These unfavourable psychological characteristics may have a poor effect on student learning results.

In addition, most school reorganizations are encountering difficulties in student monk development and training, while the 2019 coronavirus sickness pandemic has affected more than 65% of their internships and training. Due to travel limitations, lockdown measures, social distance, online learning, and travel prohibitions, most corporations have stopped offering internship training to college students. The influence of the coronavirus pandemic on education highlights the significance of the impact on African education systems, both in terms of teacher development and online or offline student learning. According to UNESCO [7] research, nearly half of students in Africa, as well as students worldwide, will be affected by partial or total school closures one year after the 2019 coronavirus disease epidemic outbreak, and more than 100 million children will have below-minimum reading skills as a result of the health crisis.

Many educators and researchers are worried about the effects of COVID-19-related school closures on student academic attainment and learning inequity. Due to COVID-19-related school closures, Wößmann assessed that 0.10-SD had a detrimental influence on student attainment [8]. Furthermore, Haeck predicted a 30% rise in the socioeconomic achievement gap [9]. The impact of 2019 coronavirus illness education on student success is currently projected to be negative. In conclusion, global school closures and other secondary impacts of the 2019 coronavirus outbreak are projected to have repercussions on children, their families, and their communities. During this epidemic, education is a complicated topic. On the one hand, school settings are at high risk of transmission of the 2019 coronavirus epidemic, and school closures are considered vital to safeguard public health. On the other side, the relationship between schools and children's health, safety, and future changes is critical. As a result, this is not a straightforward trade-off but rather one that needs careful evaluation of how learning might assist children, families, and more significant social problems.

The 2019 coronavirus illness pandemic has affected education systems since its emergence. School closures have ranged from none in a few nations to more than one school year in others. At least a third of students are unable to learn remotely due to a lack of connectivity and equipment [10]. Despite the Omicron version, most nations' schools are open with health and safety regulations and immunization regimens in place. Vaccination rates are expected to rise by the end of the 2020–21 school year, but this is perhaps the most significant challenge educators, and students have ever faced. Previous studies have found that the pandemic has a considerable influence on the learning of primary and secondary school children. The pandemic deepens already-existing achievement and opportunity inequalities, disproportionately affecting historically poor pupils.

According to surveys conducted in many nations, most students in African schools finish the school year with six months of incomplete education. High school students are more likely to drop out, particularly those from low-income households, are less likely to continue their education. This problem impacts the academic performance with more than 40% of parents worrying about their children's mental health [6]. Furthermore, the pandemic may impair this generation and limit their options as they mature into adults. A chain reaction might jeopardize their prospects of attending college and getting a career that would allow them to support their families.

While distance learning by schools and governments helps address the educational gap caused by pandemic influenza. On the other hand, distance learning was linked to a considerable rise in student workload and the resultant psychological stress from homework. Students were more likely to be distracted from their studies, have trouble organizing their learning, and be anxious that the blockade might harm their academic achievement. Furthermore, most instructors did not receive appropriate help from their colleagues. Finally, the COVID-19 outbreak has brought a significant and pressing issue: the impact of school closures and online education on learning and mental health of students [10]. These are unquestionably unusual circumstances that can cause tension and worry in students and instructors. As a result, this study will show the predictions of school closure level related with Covid and future studies should explore the influence and solutions of school closures on student learning, even during subsequent waves of contagion and account for the persistence of this stressful event pandemic.

### 3 Data Description

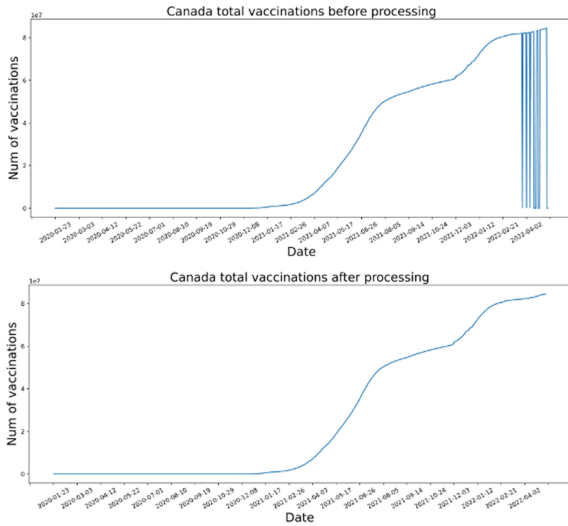
The data has been extracted from the website Our World in Data based on Covid 19 study. First, I collected data about Coronavirus (COVID-19) Cases for different countries which including the cases, deaths, vaccinations, hospitalizations, and testing etc., and it is updated daily on Our World in Data. All raw data on confirmed cases and deaths are derived from the COVID-19 Data Repository at Johns Hopkins University's Center for Systems Science and Engineering (CSSE). Second, I collected data related to school closures in different locations.

The Coronavirus (COVID-19) Cases data and School Closures data span from January 2020 to May 2022. Two sets of data have been combined and filtered out 186 countries that are duplicates in two data sets. For school closures level (Table 1), it divided into four different situations: 0 - No measures; 1 - recommend closing; 2 - Require closing (only some levels or categories, e.g. just high school, or just public schools); 3 - Require closing all levels. And under 186 countries, 32 metrics were used to consist of the data; I collected these data and study the correlation analysis of these 32 metrics with school closures to explore the correlation between attributes and check whether there is redundancy in it. In addition, by exploring the relationship between each attribute and the result, and then select the attribute with greater correlation with the result as an important feature of modelling.

The difficulties for processing data are since the raw data were not complete enough, if we use these data directly for analysis, there will be errors, then we need to fill it manually for some metrics. For example (Fig. 1), when we directly use the raw data to

**Table 1.** Example of school closures levels

Country	Jan 21, 2020	May 8, 2022	Absolute Change
China	0.00	3.00	+3.00
Solomon Islands	0.00	3.00	+3.00
Austria	0.00	2.00	+ 2.00
Bangladesh	0.00	2.00	+2.00
Belize	0.00	2.00	+ 2.00
Bolivia	0.00	2.00	+2.00
Brazil	0.00	2.00	+2.00
United States	0.00	2.00	+2.00
Brunei	0.00	2.00	+2.00
Canada	0.00	2.00	+2.00

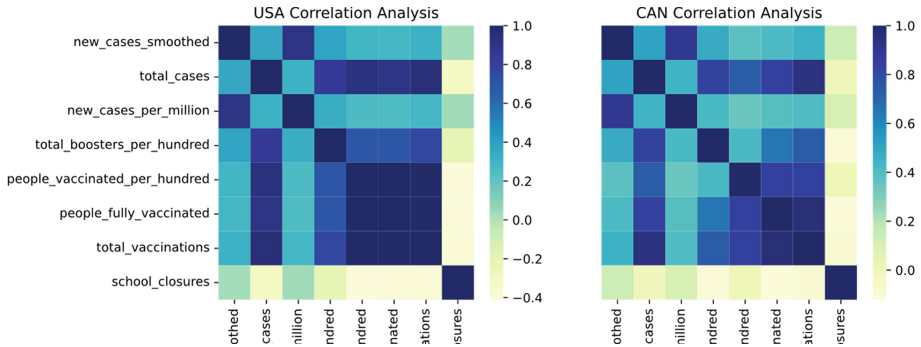


**Fig. 1.** Data comparison before and after processing

graph the number of total vaccinations, the function was discontinuity, and the data is irrational. And it also cannot maintain its non-strictly increasing feature by just filling the NA value with mean value or 0 from the data frame. Therefore, we need to process these kinds of data separately for each different country.

### 4 Methodology

In this section, the correlation analysis of data will be discussed, and decision tree algorithms in machine learning was used as the method to predict the school closures



**Fig. 2.** Correlation heatmaps of USA and CAN

based on time series analysis. Specially, in Sect. 4.1, the correlation of the metrics is tested and decide the most relevant attribute with the school closures. In Sect. 4.2, time series model is introduced, and autoregressive integrated moving average (ARIMA) model was used to predict the trend of independent variables. In Sect. 4.3, decision tree algorithms in machine learning was used to estimate the future situation of school closures after conducting the time series analysis.

### 4.1 Correlation Analysis

The correlation between two variables is a statistical measure of the strength of their relationship. Correlations can be positive or negative. Two variables are positively correlated when they move in the same direction; as one increases, the other does as well. When negative, a variable increase while the other decreases. I identify the correlation by plotting the correlation heatmap. Different variables in a correlation matrix are illustrated by correlation heatmaps. In correlation heatmaps, relationships between numerical variables are represented as a visual. Plots of correlations can be used to determine which variables are related and how strong that relationship is. Correlation values range from  $-1$  to  $1$ . Each cell indicates the strength of the relationship, where positive values indicate a positive relationship and negative values indicate a negative relationship. Country USA and CAN are filtered out (Fig. 2) to make correlation heatmap. The result shows that the school closures in these two different countries related with different metrics, since the government in different countries has its own policy and consider the school closures based on different metrics. According to that and the discussion in Sect. 3, I decided to predict the school closures individually in these two countries, and the number of new cases, new deaths and total vaccinations were filtered out to predict the school closures based on the correlation heatmaps.

### 4.2 Time Series Modelling

Success in business depends on 'time.' Time moves too fast we can barely notice what happened in the previous week but always thinking of the future. We are now able to 'see things' ahead of time thanks to the advancement of technology. Time series model

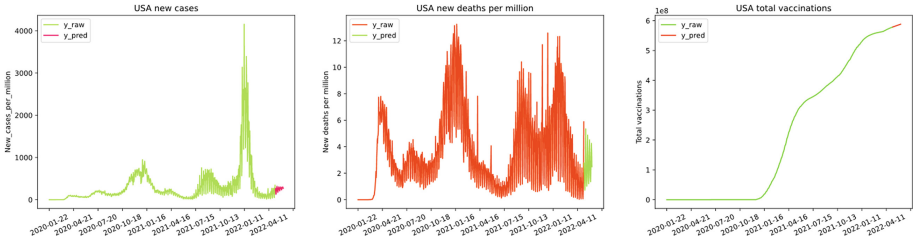


Fig. 3. ARIMA modelling prediction of USA

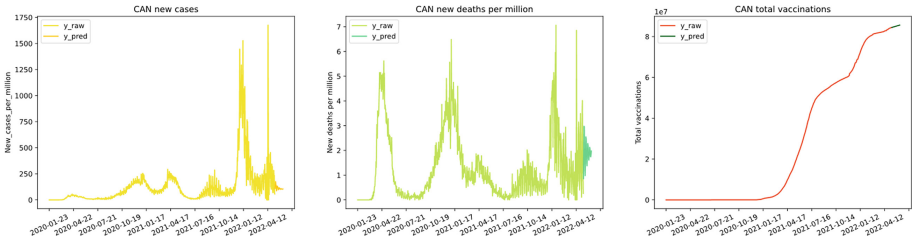


Fig. 4. ARIMA modelling prediction of CAN

can be very useful with serially correlated data. Since the number of new cases, new deaths and total vaccinations have already filtered out to predict the school closures, the prediction of these three independent metrics should do first. An autoregressive integrated moving average (ARIMA) model is used here to understand and predict the data better. (Figs. 3 and 4) A regression model that uses the AR part does so by regressing the variable of interest on its own lagged (i.e., prior) values. The MA provides confirmation that the regression error is actually a linear combination of errors that occurred contemporaneously and at different points in the past. By default, “I” indicates that the values in the data have been replaced with the difference between them and the original values (and this differencing may have taken place more than once) [11]. Having each of these features helps make the model fit the data best. And the result of prediction, the number of new cases and new deaths slightly increased compared to the previous period. The vaccination rate slows with the flat trend of total vaccination. And the change of school closures levels in the future will then be predicted by these metrics.

### 4.3 Decision Tree Modelling

To predict the future change of school closures, the decision tree algorithms model in machine learning is used to estimate the situation. Methods such as decision trees are often used in data mining to develop classification systems or predict algorithms for a target variable based on multiple covariates. By dividing the population into branch-like segments, an inverted tree is constructed that contains a root node, nodes inside it, and leaves attached to them. The leaf nodes of a decision tree can be interpreted as tests (on input data patterns) and its leaf nodes can be taken as categories (of these patterns). To match the output pattern to the input pattern, these tests are filtered through the tree. A

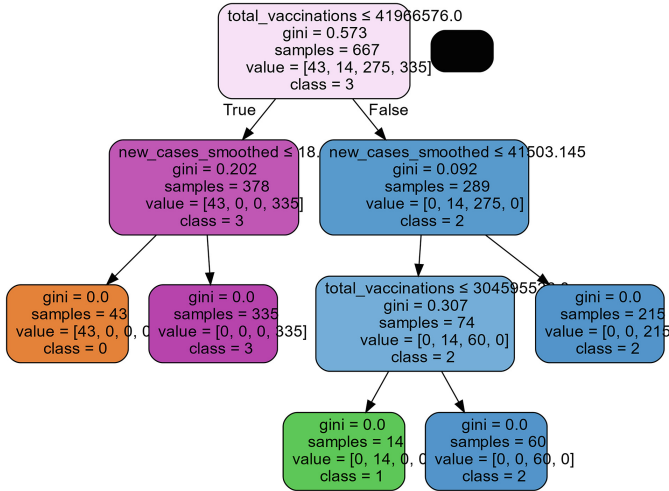


Fig. 5. Decision tree of USA

variety of different fields can use Decision Tree algorithms methods. Take the decision tree of USA as an example (Fig. 5), at the first, if the number of total vaccinations equal or less to 41966576.0, it will continue go to the left leaf; otherwise, it will go to the right leaf and then do the same processes again, until the Gini index equal to 0. By simulating the data with this model, we get a forecast of the school closures for the next 30 days (Fig. 6).

### 5 Empirical Results

The number of new cases, new deaths and total vaccinations were used to measure the level of school closures by using the decision tree modelling method. In Table 1, it shows the different level for school in each country based on the government’s policy. By simulating about 680 days’ data and result of ARIMA modelling prediction on the three metrics, the level for school closures in USA and CAN is successfully predicted. (Figs. 7 and 8) With the increase of number of new cases and deaths, the school closure level increased as well. But with the number of total vaccinations grow, the school closure level decreased oppositely. As the prediction for 30 days in the future, both USA and CAN’s school closures level remain at the 2, which indicates only some levels or categories institutions closed, e.g. just high school, or just public schools. And compared two decision trees in Sect. 4.3, we can easily see U.S. has a better visualization and less processes to get the result. This might indicate that U.S. policy may be relatively clear and simple than CAN.

For evaluation of machine learning model performance, around 80% of the data were used to make the prediction and the other 20% were used to evaluate. After the result of the prediction, the MSE of the decision tree model with these two tests are 0.71 and 0.68, that it can be confident with our result of prediction.



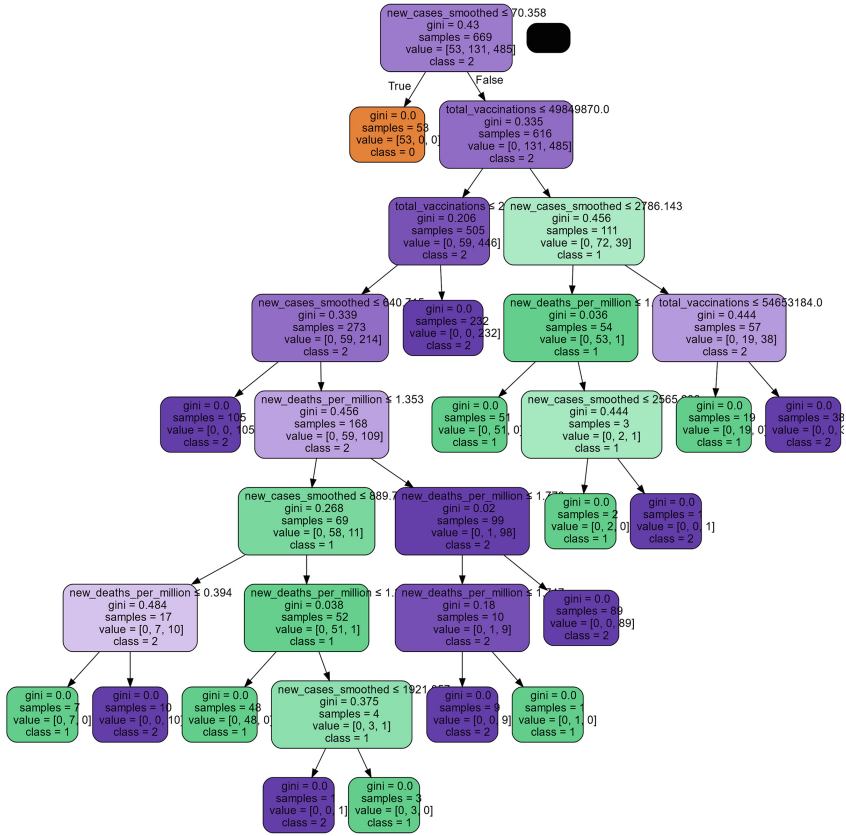
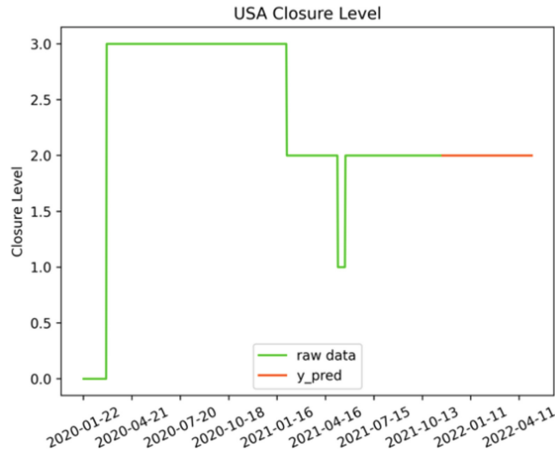


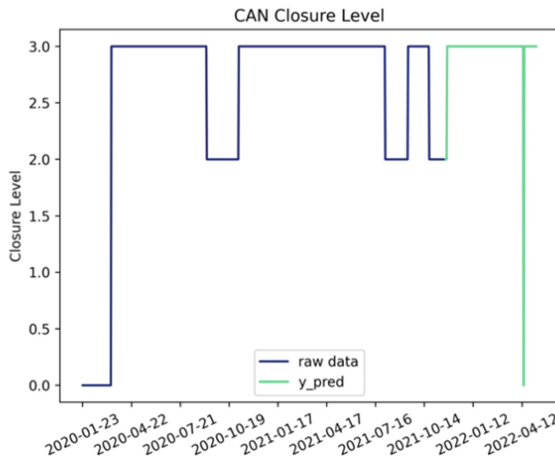
Fig. 6. Decision tree of CAN

## 6 Discussion

School closures are heavily based on the policies made by government. United States government during the education-related lockdown assisted the country in returning to normalcy more quickly than other nations [12]. This fund, established under the CARES Act Higher Education Emergency Relief Fund, provides assistance to institutions in one of the sectors of higher education that Education at a Glance tracks on an annual basis: foreign student flows. Future editions of this book may indicate a significant reversal of patterns a year after COVID-19 took place in this location, according to the author. As a result of the worldwide spread of the COVID-19 outbreak, colleges have closed their doors and governments have tightened their border controls. Students' safety and legal standing, as well as the continuity of learning and course materials, have all been compromised as a result of the crisis. If you or a loved one has been impacted by the crisis, you may be eligible for emergency financial assistance. Elementary and secondary school emergency relief funds established under the CARES Act are intended to assist school districts impacted by COVID-19 interruptions and closures. It is supported by the federal government.



**Fig. 7.** Predicted school closures level for USA



**Fig. 8.** Predicted school closures level for CAN

Schools in the United States began shutting down in March 2020 as a result of the COVID-19 outbreak. This is an unusual and historic shift in the American educational system, with institutions being forced to close. At the height of the school closures, 60,000,000 students were affected in over 120,000 public and private schools across the United States. These youngsters lost access to not only the essential support that schools offer for many students but also to group activities, sports, and leisure alternatives like swimming pools and playgrounds. Students and instructors in the United States face significant hurdles due to school closures and the resulting public health and economic concerns [13]. The countrywide impacts of school closures increased a range of societal inequities in gender, technology, educational attainment, and mental health. While the specific impact is yet unknown, evidence shows that children’s academic attainment

declines during the epidemic while other developmental abilities improve. Educational inequalities are growing due to how the crisis has exacerbated existing socioeconomic gaps and how these differences impact learning and educational performance. As a result, many of the children who would ordinarily struggle to learn successfully and thrive in school are suddenly finding it difficult, if not impossible, to obtain a good education, and are suffering learning disruptions that must be addressed [14].

A year later, it is evident that the COVID-19 epidemic has permanently altered American schooling, and flashes of this new system are already visible. Schools are creating endless virtual choices hoping that some families will continue to use distant learning after the epidemic, especially primary school students. For the first time, hundreds of institutions are accepting new students without requiring SAT or ACT scores, potentially allowing more low-income children to get admission to the most elite colleges. Thousands of educators around the country are exploring innovative methods to stimulate kids' creativity, harness technology, and offer the assistance they need to thrive, from kindergarten to college. Many education of students has been harmed as a result of this epidemic [15]. Millions of youngsters will need assistance to recover from academic and psychological trauma, which educators estimate will take years. The people did not appreciate how important schools were until they were shut down as a culture. Preschool and primary education programs are important parts of the childcare ecosystem because they allow parents to work while their children develop intellectually. They have been shown to improve long-term health and educational results. Many schools also provide crucial mental health services, medical and dental treatment and help to uncover incidents of child abuse. When schools are closed due to coronavirus sickness, children and their families in this nation receive much help. Not only have campuses changed to distant learning virtually overnight, but universities are now experiencing substantial financial issues as the domestic and global economies face what appears to be a catastrophic recession.

The development of education in Canada was found significant because the government and education department came out with some plans that are explained. For example, Canada Emergency Student Benefit, which was announced in April 2020, will be implemented as soon as possible to assist post-secondary students and recent high school graduates who are unable to find job as a result of COVID-19. Student volunteers and others who participate in national service will get additional financial assistance via the Canada Student Service Grant throughout the epidemic. According to Prime Minister Justin Trudeau, the federal government would triple student grants and widen eligibility for financial assistance as a reaction to the COVID-19 outbreak, as well as give additional scholarship funding for affected students and postdoctoral researchers [16].

Since they had to examine the effect of university closures on their status both on campus and at home, international students were especially impacted by the lockdown. Many students were forced to choose between going home with no clue when they would be able to return and remaining in their host country with limited work and educational prospects while their visa status was being resolved, which many ultimately chose. Some nations, such as Canada and the United Kingdom, exempt students from visa requirements or enable them to stay on campus while pursuing their studies [17].

As a result, education in Canada has improved dramatically, with students returning to school at a quicker rate than in other countries that sent their children home to recuperate.

According to UNESCO, school cancellations induced by COVID-19 would affect more than 1.5 billion students in 165 countries by the end of March 2020 [7]. In early May, less than 8% of Canadian students were enrolled in government schools; especially the pandemic has significantly impacted education and learning in Ontario. The schools of Ontario were closed for a total of 20 weeks, longer than any other province or territory in Canada [18]. This encompasses both large-scale and local school closures and a variety of educational delivery strategies and support gaps for children with disabilities. The unequal distribution of school closures and pandemic-related hardships, which disproportionately affect low-income families and disproportionately affect Aboriginal groups and people with disabilities, appears to be deepening and accelerating inequities in educational outcomes wherever data is collected [19]. Furthermore, school closures pose health concerns to children, including considerable harm to their physical and emotional health and safety. This results disparity reflects current government recommendations in these states, which indicates the disparity in infection rates. It will take some time to determine the impact of disruption on learning outcomes, but preliminary evidence from worldwide studies suggests that students from low-income families will be the most affected. The reaction of education sector has been impacted by diverse state and territory term dates and COVID-19 illness cases in each jurisdiction. According to experts, the COVID-19 outbreak will have a long-term impact on schools and students in Canada, including the health system and economy [20].

At the same time, students must have access to the necessary equipment and bandwidth to participate. This is not attainable for certain students, particularly those from low-income households or those in high-risk situations. These developments and other challenges that have been highlighted in studies, such as the consequences for education providers financial sustainability, emphasize the new and extra threats that higher education quality and the integrity of the education sector are confronting. The study reveals that the pandemic is playing a role in hastening many of the trends and changes currently underway in the higher education system of Canada, notably the transition to blended and online delivery modalities. For example, the announcement about the British Columbia government had resumed K-12 classroom instruction, which had been suspended due to the COVID-19. The public forums have erupted with parents questioning the safety of returning students to school at this time and expressing concern for their emotional well-being. They also wanted to know if the school setting was frightening for youngsters who had been spared from the pandemic's realities at home. Teachers pondered how they might keep their children safe without frightening them and how they could support both online and face-to-face learning [21]. The research reveals that the pandemic is playing a role in hastening many of the trends and changes currently underway in the higher education system, notably the transition to blended and online delivery modalities. Other structural impacts of coronavirus illness in Canadian higher education, such as the diversification of strategies to change the delivery of international students from an input to a mixed model, are combined with these considerations.

For individuals who have access to the appropriate technology, online learning seems to be more successful than traditional methods of instruction. According to several

research, students who study online retain 25–60 percent more information than those who learn in a traditional classroom [22]. It takes 40–60% less time to complete online learning than traditional classroom learning because students may study at their own pace, going back and re-reading sections and ideas, skipping sections and ideas, or speeding through topics as they see fit [12]. Regardless, the efficiency of online learning differs depending on the age of the learner. Children, particularly younger children, are regarded to need a supervised setting because of their proclivity to get distracted by their surroundings. It is vital, according to Dowson Tong, Tencent's senior executive vice president who also serves as president of the company's Cloud and Smart Industries Group, to provide this foundation in order to maximize the benefits of online learning. Collaboration and engagement platforms must be used to foster "inclusion, personalization, and intelligence," rather than the other way around [16].

## 7 Conclusion

The scholarly articles show the impact of digital and statistical analysis-based technologies in combination with the educational matters have done wonders in the field of science and research. Several digital technology and statistical methods were used to define and interpret the data during Covid circumstances of educational institutes and are even being done today. So, the summary of data could use for further analysis and conclusions. Moreover, for further refinement, the statistically analysed data and correlation with the metrics could be passed through different models to get more detailed regarding educational school closure.

The prospects in post covid era seem bright and, especially when it comes to the education sector. It is obvious that the covid pandemic that arise in the late 2019s the impact of the epidemic on schools is gradually diminishing. And the world has learned the concept of online teaching and learning. It does not seem like the education sector would further face any loss. And the government of different countries has learned to deal with it and prepared the different polices to overcome the emergency situations. Also, the vaccine has not only been developed rather it has been distributed widely. The world health organization's work in this regard specifically deserves appraisal. We together have fought the pandemic and are dedicated enough to do so in the future also.

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