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Dynamics of Online Learning Perceptions During the COVID-19 Pandemic and Post-pandemic

Zixi Wu[1,a], Xinyue Fei[2,b], Baoyan Liao[3,c,*], Yiyao Huang[4,d]

[1]Letter & Science, University of California, Davis, Davis, 95616, America
[2]Basis International School Park Lane Harbor, Shenzhen, 619000, China
[3]The Affiliated International School(YHV) of Shenzhen University, Shenzhen, 518055, China
[4]QSI International School of Dongggguan, Dongguan, 523000, China
a. dswu@ucdavis.edu, b. xinyue.fei40253-biph@basischina.com, c. 1548209904@qq.com, d. viannahuang3720@163.com
**corresponding author*

Abstract: During the pandemic, people were forced to utilize multiple online learning apps as platforms, allowing them to continue education. Though many people benefit from online learning, the public still holds different attitudes toward it. This research examines the impact of online classes on people's attitudes, with a primary focus on the shift in attitudes toward online learning during the COVID-19 pandemic. It encompasses two main questions: 1. How did the public's attitude towards online learning change during the pandemic on Twitter? 2. What are the differences in the dynamics of the public's attitude towards online learning on Twitter during the pandemic compared to the post-pandemic period? Our team employed a variety of methods to address these questions. They gathered a substantial amount of data and examined specific tweets to gain more detailed insights. The results indicate a change in people's attitudes toward online learning during the pandemic. Initially, many individuals were not fond of it and had uncertainties. However, as time passed and lockdown measures continued, people began to accept and enjoy online learning. The perceptions of online learning differed between the pandemic and post-pandemic periods. After the pandemic, positive sentiments like the convenience and flexibility of online learning became more prevalent. These findings are significant as they help understand how people's opinions about online learning evolved during and after the pandemic and how people accept online learning as an educational technology.

Keywords: online learning, dynamics of public's attitudes, pandemic, MDCOR, educational technology

1. Introduction

The outbreak started at the beginning of 2020; by the end of 2022, it had been going on for three years. Governments are forcing educational institutions, schools, and universities to embrace online learning to ensure education continues. Zoom, Tencent, and Dingding have emerged as platforms for online education and are employed in several instances. Classes can be held at home, which is more convenient and maintains a social distance that successfully stops the virus from spreading. However, when individuals combine their online learning experiences in secondary schools or universities, they

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will discover that online learning is a somewhat contentious topic. During the pandemic, people were forced to choose online learning. However, there are numerous issues, such as poor supervision of student homework completion, lack of self-discipline on the part of the students, and their abandonment of the class, tiny movements, and cutting of the screen to play games and chat. Teachers cannot check their students ' attendance because they frequently forget to turn on the cameras. Considering these issues, some people are ecstatic that offline schooling has resumed following the outbreak, while others miss online education.

This topic aims to discover what the general public believes about online education and social media and track any changes in that opinion over time. It is essential to consider whether the general population embraced online learning during the epidemic, whether attitudes about it altered as the epidemic progressed, and whether the drawbacks of online learning came to light.

2. Literature Review

The public's attitude towards online learning has significantly shifted during and after the pandemic, as evident from Twitter discussions. Many users praised the flexibility and accessibility of online learning, especially in the face of lockdowns and social distancing measures [1]. However, challenges also surfaced during this period, with some expressing concerns about the effectiveness of virtual learning, issues with internet connectivity, and the potential impact on students' social development. As the pandemic subsided, the public's attitude towards online learning on Twitter likely evolved. Some may continue to appreciate its benefits, leading to its integration into traditional education systems, while others might advocate for a return to in-person learning [2].

By searching and reading relevant literature, scholars have already shed light on these existing research interests, including academic performance, mindset change, and limitations of online learning.

2.1. Academic Performance

On the one hand, the rise of online education has had a significant impact on students' academic achievement. Students now have a variety of options to visit their favorite websites, owing to the popularity of social networks. Due to the nature of online classes, the only means for teachers to observe what students are doing is through the camera, but since the camera can only see students' faces, it is impossible to obtain an accurate and complete image of what they are doing. Thus, numerous academics have conducted studies to address this problem.

They discuss the difference between studying Student Learning Outcomes in Online and Offline Learning during the Pandemic [3]. Learning outcomes are one of the critical indicators of the effectiveness of learning and the achievement of learning objectives using the result of the Basic Course of Physics Learning Process to determine the impact of online and offline learning on learning outcomes. Based on descriptive statistics on research data, there is a difference in the average student learning outcomes between online learning and offline. But surprisingly, this document revealed a result that no one expected. In the stereotype, offline learning is perceived to be more effective than online learning, but the average score of online test results is even higher than that of offline learning. Along with that, another study utilized the use of quasi-experimental design to prove the same results. Data were collected from 368 students enrolled in three online and three face-to-face sections of an introductory-level sociology course. The investigators compare student satisfaction and student performance on midterm exams and an integrating data analysis assignment [4]. Ordinary least squares regression is used to evaluate the effect of the different course settings, independent of demographics and control variables like age and gender. Results indicate that differences in student performance between the two settings may be accounted for by the presence of a selection effect and

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that student satisfaction does not significantly differ across the two settings. These findings are interpreted to mean that when online courses are designed using pedagogically sound practices, they may provide equally effective learning environments.

Both articles utilized comparative and quantitative methods to identify the differences in student learning outcomes in online and offline learning through quasi-experiments on 18 students. The results show that online learning is more flexible, feasible, and effective than offline learning and can be a good option during the pandemic. These two publications are helpful to the project since they allow for referencing the methodology and using the hypothesis and conclusion to guide further investigation.

2.2. Mindset Change

On the other hand, online classes also impact students' mindsets concurrently, causing a shift in their mindset as a result of the epidemic's spread and the abrupt switch from the offline to the online modes, which they are unaccustomed to. Additionally, some academics have studied this topic in depth.

Due to the COVID-19 epidemic, educational institutions were compelled to switch from traditional classroom settings to remote learning, providing students and teachers with several psychological and practical difficulties. The post emphasizes the importance of a positive outlook for overcoming these difficulties. To benefit from the new educational setting, students needed to modify their attitudes toward and views of online learning [5]. Another essential factor that evolved in this situation is motivation. The lack of face-to-face contact and the convenience of a physical classroom made maintaining motivation a priority. The essay examines methods for retaining students' interest and motivation, including individualized instruction, engaging technology, and frequent teacher-student interaction. The third major topic covered in the article is adaptation. Both teachers and students had to modify their teaching and learning methods to fit the online environment. Adapting curriculum delivery to remote learning environments required developing digital literacy skills, mastering new technology, and knowing how to use new software.

The impact of online Internet classes on students is examined in this article using survey data in Excel. The paper analyzes data from two student groups and discovers that both had generally favorable or neutral sentiments toward the online learning environment. Reading this literature provided insight into the public's perception of online classes, serving as a source of material for subsequent research.

2.3. Limitation of Online Learning

In addition, online learning has several drawbacks, including a decrease in the interaction between professor and student. A few articles have done extensive research on this subject.

One research used a survey to investigate students' satisfaction with online learning during COVID-19, especially IT students. In this research, a survey study on IT students' opinions of online learning during the COVID-19 epidemic is presented [6]. The study investigates how students viewed the shift to online schooling brought on by the epidemic. The research uses survey data to offer insights into students' experiences, difficulties, and general satisfaction with this learning modality. Although students can learn effectively and comfortably online, some difficulties remain. From the survey data, we can infer that, out of 130 students, 63.8% thought online learning reduced interaction with professors and friends, 54.6% reflected that it would result in social isolation, and 57% encountered technical difficulties while learning online. This article shows us one drawback of online education: it will lessen the student-teacher connection, precisely the subject we should study. It also provides data on student evaluations of online learning to prove that it is not entirely favorable.

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Another essay discussing the lack of social interaction in online classes has also shown us the same results. This essay explores the absence of social engagement that online learners encountered during the COVID-19 pandemic [7]. It draws attention to the difficulties kids have connecting with peers and teachers and their potential effects on their educational opportunities and general well-being. The study looks at the causes of the decreased social connection, like technical constraints or a lack of familiarity with online platforms. It also looks at possible approaches and techniques to improve social interaction in online classes, highlighting the significance of creating a welcoming and engaging learning environment for students with little opportunity for face-to-face connection.

3. Methods

3.1. Study Design

This research adopted an observational study design to rigorously delve into the dynamics of public attitudes toward online learning. The primary objective was to compare these attitudes across two critical timelines: during the pandemic and post-pandemic.

3.2. Participants

The dataset's backbone consisted of comments sourced from Twitter, one of the world's largest real-time communication platforms. These comments, acting as reflections of public sentiment, offered a goldmine of insights into evolving perceptions surrounding online education in unprecedented times [8].

3.3. Materials and Instruments

Academic Twitter: A specialized tool tailored for rigorous academic exploration on Twitter, it was instrumental in sifting through the deluge of tweets and extracting comments aligned with the research topic. [9].

Machine-Driven Classification of Open-ended Responses (MDCOR): Deployed for intricate text mining and data cleaning processes, MDCOR allowed for sophisticated analysis of the amassed comments, facilitating meaningful interpretations of public sentiment [10].

3.4. Procedures

3.4.1. Data Collection

Utilizing the capabilities of Academic Twitter, comments bearing the hashtag #onlinelearning were pinpointed within the specified period from April 29, 2020, to December 31, 2021. From a vast sample size of 650,000 comments, we strategically selected 4,493 for each of the two periods. The rationale behind this range was to ensure a dataset that is both manageable for comprehensive analysis and sufficiently extensive to guarantee robust insights.

3.4.2. Data Loading on MDCOR

The next phase entailed uploading the collected dataset into MDCOR (Fig. 1). The software requires a minimum of two columns for effective functionality: a unit ID and a column populated with open-ended responses (in this case, Twitter comments). While an additional categorical or group column can be beneficial for code associations, it remained optional within the research parameters.

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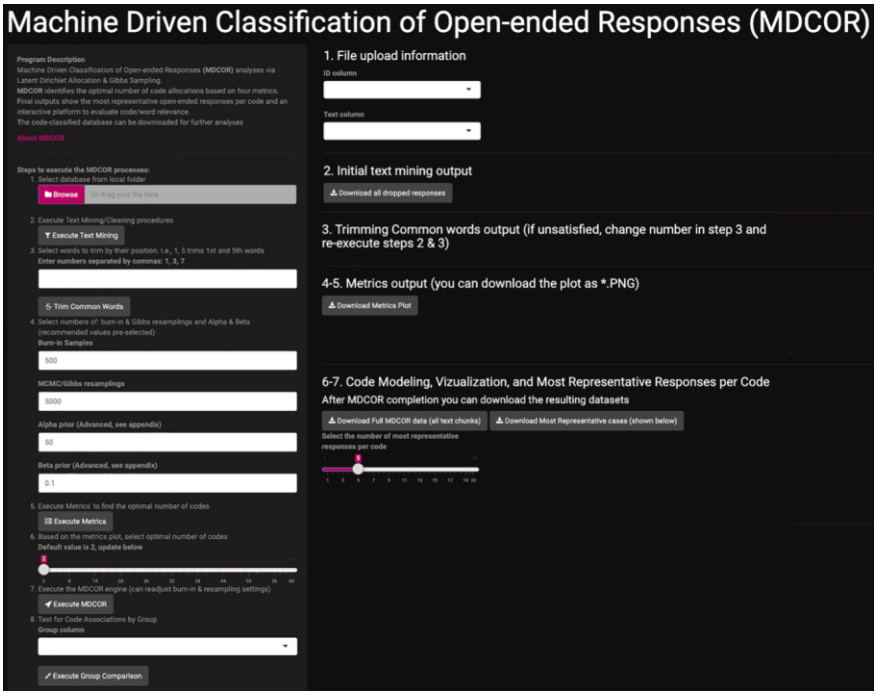

Figure 1: User Interface Platform.

3.4.3. Text Mining/Cleaning

Given the machine-learning prerequisites of MDCOR, certain responses might be rendered unsuitable for classification if peppered with sparse, unique, or outlier words. Such words tend to distort probability learning and hinder the association with a latent code. To combat this, we initiated a process to identify the top 20 most recurring words. From this list, 30% of the most frequent words were eliminated. Additionally, words bearing synonymous meanings were amalgamated to ensure cleaner, more precise data. Below are the during-pandemic samples before (Table 1) and after (Table 2) the text mining.

Table 1: Text Mining/Cleaning and Top 20 Most Frequent Words.

	words	frequency
1	remote learning	1123
2	distance learning	1055
3	learn	963
4	student	856
5	eLearning	718
6	online learning	506
7	much	467
8	have	443
9	online	435
10	teacher	430
11	school	376
12	free	333
13	today	326
14	work	313
15	make	309
16	good	304
17	help	297

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Table 1: (continued)

18	time	289
19	course	268
20	share	261

Table 2: Top 20 Most Frequent Words after Removing the Most Common Words.

	words	frequency
1	learn	963
2	student	856
3	much	467
4	have	443
5	online	435
6	teacher	430
7	school	376
8	free	333
9	today	326
10	work	313
11	make	309
12	good	304
13	help	297
14	time	289
15	course	268
16	share	261
17	week	261
18	great	258
19	covid	254
20	education	249

3.4.4. Sampling Parameter Selection

Building on our methodological approach, machine learning sampling parameters were defined. In alignment with recommended best practices, a burn-in phase of 500 was chosen, followed by a posterior resample of 5,000.

3.4.5. Optimal Topic Selection via Metrics

A visual metrics plot (Fig. 2.) was generated, spotlighting data patterns and facilitating the discernment of the ideal number of topics within our comment dataset. This visual tool was indispensable in guiding our subsequent analytical endeavors.

3.4.6. Optimal Code Selection

Our research then focused on identifying points on the metrics plot (Fig.2.) that indicated the lowest convergence. These specific points were pivotal in designating the optimal codes for categorization and in-depth analysis.

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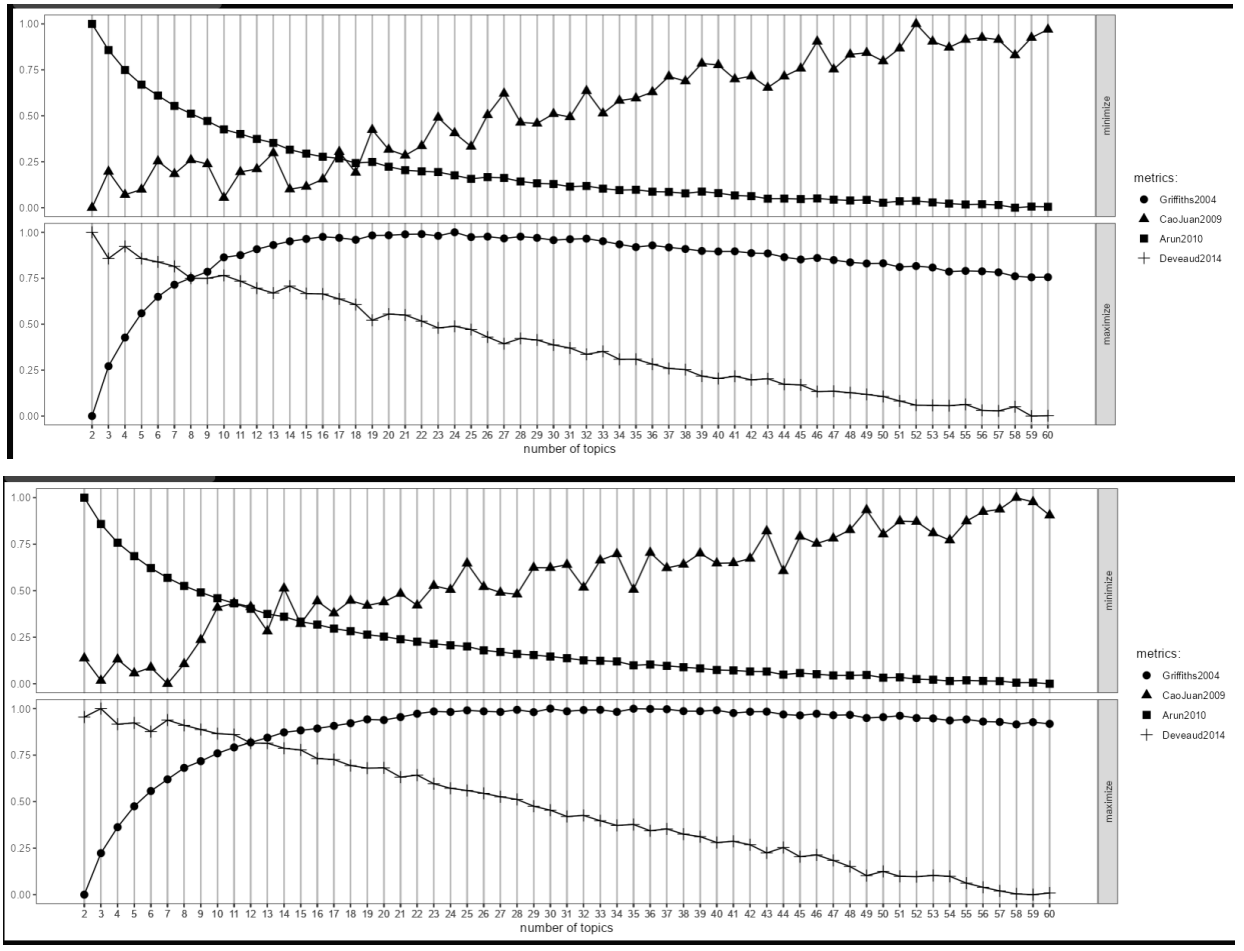

Figure 2: MDCOR Assessment Metrics Showing the Convergence of Two Metrices.

3.4.7. MDCOR Execution

With the cleaned, categorized, and meticulously prepared dataset, the exploration of the comments was conducted using MDCOR for in-depth analysis. This stage unveiled layered nuances, sentiments, and predominant themes that resonated within the public discourse during and post-pandemic.

3.5. Data Analysis

Drawing on the meticulous groundwork laid in the procedures, our research transitioned into a comparative analysis phase. Public sentiments from two distinct periods were juxtaposed: during the pandemic and post-pandemic. The structured codes and detailed insights teased out via MDCOR were integral in navigating this phase, enabling a methodical and enlightening traversal of public opinions [11].

4. Results

Following the deployment of the Machine Driven Classification of Open-ended Responses (MDCOR) on our dataset, several consequential outputs materialized which offered a magnified lens into the intricate web of public sentiment regarding online learning.

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4.1. MDCOR's Outcomes

The primary outcome was a descriptive summary (Fig. 3.), which manifested in visually arresting word clouds, exhibiting the top 30 pivotal words that mapped onto each code. The word clouds, besides being an engaging visual aid, held latent indications about the configurations of the codes they represented. Notably, the proximity or distance between these codes in the box quadrant plane illuminated similarities or discrepancies in the underlying semantics of these codes [12].

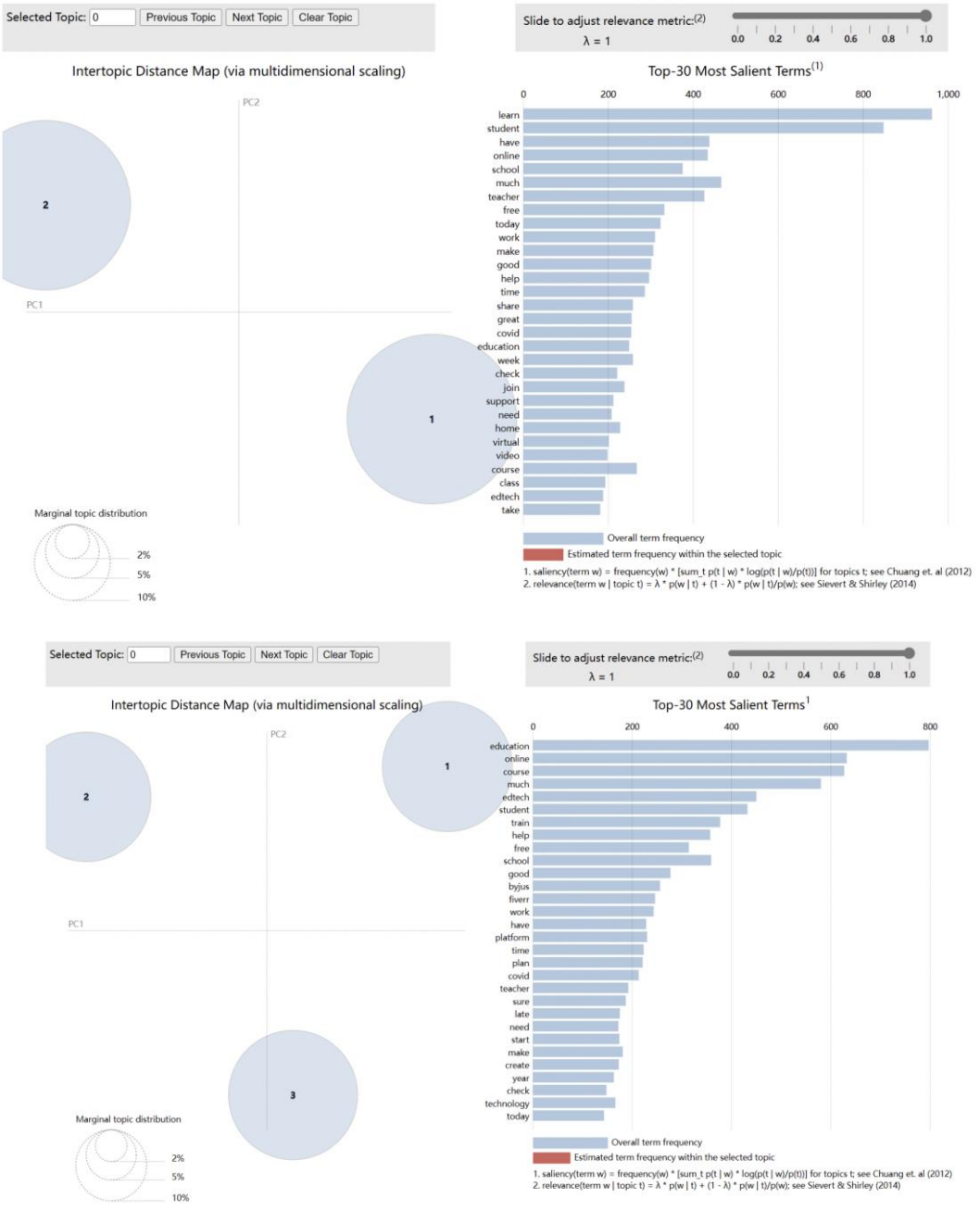

Figure 3: During & Post-Pandemic Word Clouds and Word Summaries of each Latent Code.

However, of utmost importance was MDCOR's other key output: a fully classified dataset delineating all the texts and their associated codes. For an enhanced qualitative comprehension of this data, MDCOR's user interface showcased a truncated dataset (Table 3) containing the most illustrative

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20 texts per code. The granular examination of these datasets facilitated an enriched interpretation of the overarching themes prevalent in public discourse [13].

Table 3: Example of Code Classification, Original Text Inputs, and Measures of Fit.

1	V1	1	0.991	HTMLEDUCATION ELEARNING FREE Learn HTML Introduction to creating your first website Explore how to write 0.991 HTML code to create a website with source code and step by step instructions Rated 47 stars FREE website professional create code ude httpstcoXC2ilpLzyZ	2591443279	433
2	V2	1	0.99	I cant with people who act like its a big conspiracy that flu numbers were down last year and that theyre back up now 0.99 that regulations have loosened Last year we were told to stay home social distance wear masks wash hands and we did eLearning Are you serious		
3	V3	1	1	Education is the passport to the future for tomorrow belongs to those who prepare for it today U0001D7EEU0001D7ECU0001D7EEU0001D7EEU0001D7EEU0001D7EF1 U0001D5D4U0001D5F1U0001D5FAU0001D5F6U0001D600U0001D6000001D5F6U0001D5FC U0001D5FBU0001D600 U0001D5E2U0001D5FDU0001D5F2U0001D5FBAdmissionsOpen admissions202223 School Admission Open best schools near me nursery CBSE students eLearning The Narayana Group httpstcoBkXn5uR690		

4.2. Themes of “During Pandemic”

4.2.1. Online Learning and Its Impact on Education

Edtech's Role: There was evident emphasis on EdTech’s pivotal function in buttressing remote learning during this time of crisis.

Resource Provision: The public heralded the online platforms for providing continual learning resources during the pandemic.

Pandemic Mitigation: The prevention of COVID-19 spread was underscored, signifying online learning's salience as a safe conduit to education.

4.2.2. Students and Teachers’ Perceptions of Online Learning

Predominantly Positive: The sentiment skewed towards positivity, with participants acknowledging the platform's efficacy in ensuring academic continuity.

Sustenance of Interactions: Despite physical disconnect, online learning platforms successfully bridged the interactive chasm, allowing for ongoing teacher-student engagements.

4.3. Themes of “Post-Pandemic”

4.3.1. Online Learning as Educational Technology

Technological Development: Conversations were rife about the evolution of platforms, software, and coding infrastructures, serving as the linchpins of online education.

Diverse Applications: The scope of online learning tools was noted to have broadened, finding applications beyond just academics and venturing into the educational business sphere.

4.3.2. Primacy of Education

Dedication's Dividends: A prevailing sentiment suggested that individuals who assiduously engaged with online studies during the pandemic stood in a better stead in the post-pandemic world, compared to their less-driven counterparts.

Sustenance and Connection: The tools, especially EdTech, were lauded for keeping the flame of learning alive during COVID-19, acting as the nexus between students and educators.

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4.3.3. Regulatory Backing and Online Education

Positive Resonance: The feedback around regulations supporting online learning was overwhelmingly positive.

Systemic Fortification: Such regulations were perceived as keystones in constructing a robust educational architecture bolstered by online learning modules.

4.4. Interpreting the Findings

Synthesizing these delineated themes, an overarching narrative emerged. The populace, overall, harbored favorable inclinations towards online learning. The unforeseen challenges posed by the pandemic didn't merely underscore the value of EdTech and online platforms as interim solutions. Instead, they highlighted their importance as permanent pillars in a progressively evolving academic landscape.

The experiential lessons from the pandemic, coupled with the insights extracted from our dataset, paint a clear portrait: in the post-pandemic epoch, online learning and EdTech are not transient phenomena. They are cherished, embraced, and considered foundational to a resilient and encompassing educational ecosystem.

5. Discussion

Online learning, shifting from a temporary means of keeping students on track during epidemics to prevent breakdowns and disturbances in the education system to a long-lasting, friendly educational technology, attracts people's attention from merely discussing what advantages it brings to how to improve its efficiency maximally, although online learning platforms that existed before the epidemic, such as Coursera. In order to achieve this goal, researchers are drilling to discover factors that affect people's attitudes towards online learning and provide a reference for future online learning by conducting an empirical study through a database and making quantitative analysis allowing for the measurement and organization of all dimensions to illustrate some complex concepts such as what are the characteristics of effective online teaching and learning.

A wide variety of factors exert significant influence on the efficiency of online learning, ranging from students' self-discipline to teachers' teaching, including the mastery of online teaching techniques and the elaborately designed teaching activities predisposed by teachers. The ultimate efficiency of online learning is often adversely affected by inadept manipulation implemented by teachers who often waste time troubleshooting the equipment, realize there is no share screen halfway through the lecture, and frequently ignore the chat box, which may distract students' attention from the class. In order to address such awkward situations, what teachers are supposed to do is have complete class preparation and combine the features of online learning platforms with some in-class activities that can energize the learning environment, giving students a better experience and increasing their sense of participation.

5.1. The Promising Future

This research aims at researching the attitudes of the public towards online learning, which is a radical new way of learning because it represents an advance in technology. The result of this program provides a reference model for future technological products to simulate the acceptance of new technology, which can also be adopted by the government, which may issue a series of policies to improve the popularity of this new technology and manipulate the boundaries of how this technology can be used or by some researchers who improve the quality of technology and optimize the shortcomings to meet customers' demands.

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In addition, the result also provides a comparison among online learning platforms, which includes the data of sentiment analysis, which can be applied to a further model to evaluate people's comments in the forums of the learning platforms, creating a more accommodating social software environment for the more effective removal of negative sentiment by allowing researchers to compare different sentiment derived from distinct people related to various platforms. What's more, this result also discovers the disadvantages of each online learning platform and proposes how to improve them.

5.2. Limitation

Admittedly, this research indeed has some drawbacks because it is unavoidable to have subjective opinions held by different people who undeniably decode the same thing into different meanings. Besides, for comments online, many people may have passive-aggressive behavior due to language barriers-which are often caused by second language acquisition, which interferes with people whose first language is not English to express themselves accurately and appropriately in English. Another unneglected drawback is big data handling, which results in generalized data so that these results will not be targeted since the data collected is merely from a single platform, which may show an iceberg of the whole picture.

6. Conclusion

The methodology of this study uses the MDCOR software layer sequence based on the r-language, analyzing data in terms of three aspects: sentiment analysis, topic modelling, and word frequency by means of extracting 5,000 comments from the huge database of 650,000 comments in the first six months and the second 6 months of the epidemic, providing answers of questions of this study, "How did the public's attitude towards online learning change during the pandemic on Twitter?", "How about post-pandemic? How about post-pandemic?" and "What are the differences between during pandemic and post-pandemic?". Overall, online learning after the pandemic has been attached to great importance since it not only serves as a crisis response to minimize the adverse effects but also as an integral part of a more resilient and inclusive education system.

The result of this research provides people with a predictive model for the future acceptance of the public and an optimized plan for online learning platforms.

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