

Impact of Internet Connectivity and the Digital Divide on Students' Academic Performance During COVID-19 Online Learning: A Survey-Based Study

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Abstract

The COVID-19 pandemic forced educational institutions worldwide to shift from traditional classroom teaching to online learning. While this transition ensured the continuity of education during lockdowns, it also exposed major inequalities in internet access, device availability, and digital skills among students. This study investigates the impact of internet connectivity and the digital divide on students' academic performance during COVID-19 online learning. Data were collected from school and college students using a structured survey to identify challenges faced during remote education. The results indicate that many students experienced unstable internet connections, limited data access, shared devices, and dependence on smartphones, which affected their participation in live classes and completion of academic tasks. Students with poor connectivity reported reduced engagement and lower academic performance compared to those with reliable internet access. The study concludes that reliable internet connectivity, appropriate digital devices, and improved digital literacy are essential for effective online learning. Strengthening digital infrastructure and ensuring affordable access to technology are necessary to support inclusive and effective future learning systems.

Keywords

Online Learning, Digital Divide, Internet Connectivity, Academic Performance, Remote Education, COVID-19.

1. INTRODUCTION

The COVID-19 pandemic caused an unexpected disruption in education systems worldwide, forcing institutions to rapidly shift from traditional classroom teaching to online learning environments. To prevent the virus from spreading, schools and higher education institutions stopped in-person classes and quickly moved to online learning. This sudden shift allowed education to continue during lockdowns, but it also exposed serious issues related to internet access, access to digital devices, and readiness for remote education. As online learning became the main way of teaching, existing inequalities in access to digital resources became clearer.

Effective online learning relies on reliable internet access, suitable digital devices, and sufficient digital skills. However, these needs were not equally met for all students. Many learners had to rely on smartphones and mobile data plans, while others shared devices within their families. Unstable internet connections and limited data often interrupted live classes, reduced interaction, and made it hard for students to stay on track with lessons.

Although online platforms like virtual classrooms and learning management systems helped maintain educational continuity, they also brought new challenges. Limited interaction between students and teachers, technical issues, and problems with assessments impacted the quality of learning and motivated students. Moreover, missing hands-on learning opportunities, especially in subjects that require practical or lab work, negatively affected students' academic experiences.

The pandemic also emphasized the role of digital literacy in online education. Many students and teachers did not have prior experience using digital learning tools, which lowered the effectiveness of online instruction. The rapid change left little time for training or adjustment, raising stress levels and affecting overall learning outcomes.

In reaction to the difficulties of remote learning, governments and educational institutions launched various digital initiatives to support students. While these efforts made it easier to access online learning resources, their

effectiveness varied because of differences in internet infrastructure, device availability, and digital skills among students.

In this context, the present study looks at how internet connectivity and the digital divide affected students' academic performance during COVID-19-related online learning. By examining the experiences of both school and college students, the study aims to uncover key challenges linked to remote education and to point out areas for improvement. The findings aim to help create more inclusive, resilient, and effective online and blended learning systems for the future.

1.1 MOTIVATION

The sudden shift to online learning during the COVID-19 pandemic changed how students experienced education. While classes continued through digital platforms, not all students had equal access to reliable internet or appropriate devices. Many faced slow connections, limited data, or had to study solely on smartphones, which made learning harder and more stressful.

This study is driven by the need to understand how these digital challenges impacted students' academic performance. By looking into the role of internet connectivity and device access, the research aims to highlight existing inequalities and support the development of more inclusive and effective online and blended learning systems in the future.

2. LITERATURE REVIEW

The COVID-19 pandemic caused a rapid transition from traditional classroom teaching to online learning across the world. This shift increased dependence on digital technologies and highlighted several challenges related to internet connectivity, device availability, and digital skills. Many researchers have examined students' learning experiences and academic performance during this period.

Csorba and Dabija [1] analyzed students' learning experiences during the pandemic and observed that although students gradually adapted to digital learning platforms, issues related to motivation, engagement, and academic performance continued to affect learning outcomes. Their study suggested that proper technological support plays an important role in improving students' acceptance of online learning.

Similarly, Noor and Ratra [2] examined the opportunities and challenges associated with online education during COVID-19. Their findings showed that while online learning ensured continuity of education, problems such as poor internet connectivity, lack of digital devices, and increased stress negatively affected student satisfaction and academic performance.

Maurya [3] focused on internet accessibility and the digital divide within the Indian education system. The study reported significant differences between urban and rural students in terms of internet availability and affordability. Limited connectivity and weak digital infrastructure were identified as major barriers to students' participation in online learning.

Qadeer et al. [4] investigated the impact of online learning on educational quality and found that reduced student–teacher interaction, technical issues, and challenges in assessment methods negatively influenced learning outcomes. Similarly, Selvaraj et al. [5] reported that students experienced reduced concentration, limited interaction, and lower engagement during online classes due to the absence of a structured classroom environment.

International reports also highlighted the global challenges of remote learning. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO) [6], school closures disrupted learning continuity and widened educational inequalities, especially among disadvantaged students. Likewise, the World Bank [7] emphasized that limited internet access and insufficient digital skills reduced the effectiveness of remote learning in many regions.

In India, the Ministry of Education [8] introduced digital initiatives such as SWAYAM, DIKSHA, and e-Pathshala to support remote education. Although these platforms improved access to learning resources, their effectiveness was affected by unreliable internet connections and limited device availability among students.

Abumalloh et al. [9] examined the role of virtual laboratories and reported that although virtual labs supported remote learning, they could not fully replace hands-on practical experiences. Similarly, Agarwal [10] highlighted the rapid digital transformation of education during lockdowns while identifying infrastructure limitations and digital inequality as major challenges.

Furthermore, Gupta et al. [11] emphasized that online learning requires significant modifications in curriculum design and assessment methods to ensure effective learning. Nisa et al. [12] concluded that although online education increased flexibility and accessibility, its effectiveness was limited due to technical challenges and unequal access to digital resources.

Overall, previous studies indicate that while online learning ensured continuity of education during the COVID-19 pandemic, differences in internet connectivity, digital device availability, and digital literacy significantly influenced students' learning experiences and academic outcomes. However, limited research has specifically examined how the quality of internet connectivity and dependence on digital devices directly affect students' academic performance, which this study aims to address.

2.1 Research Gaps Addressed by This Study

- Existing studies mainly talk about the general benefits and challenges of online learning. They rarely examine how the quality of internet connectivity and dependency on digital devices specifically impact students' academic performance.
- There is little comparative analysis between school and college students. We need to understand how differences in internet access and digital resources affected their online learning experiences during the COVID-19 pandemic.
- Most research highlights the availability of digital platforms and initiatives. However, students' real-world access issues, such as unstable networks, limited data plans, and shared devices, are not explored enough.
- Previous studies often focus on technology use. They rarely look at student's perceived learning outcomes, engagement levels, and academic performance during emergency remote learning.
- There has been limited attention given to identifying practical challenges that hinder the effectiveness and inclusiveness of online and blended learning systems in future educational disruptions.

3. SYSTEM DESIGN

This study uses a quantitative, survey-based research design. It is supported by thorough secondary research from published academic literature and institutional reports. The main goal of the system design is to collect, process, analyze, and interpret data related to internet connectivity, digital device availability, and their effects on students' academic performance during the COVID-19 shift to online learning.

3.1 Research Design

The research takes a cross-sectional study design. Data is collected from respondents at a single point in time. This method is suitable for examining the immediate effects of internet access and device availability on students' academic performance during the COVID-19 online learning period. By comparing responses from school and college students, the study looks at how differences in digital infrastructure and learning environments affected participation, engagement, and performance in virtual education systems.

3.2 Primary Data Collection

Primary data came from a structured questionnaire designed in Google Forms. The questionnaire was carefully created for clarity, relevance, and ease of response. It included multiple-choice and Likert-scale questions about students' experiences with online learning.

The survey gathered information on these key parameters:

- Type of digital device used for online learning (smartphone, laptop, or tablet)

- Quality and reliability of internet connectivity (good, average, or poor)
- Frequency of data limitations and network interruptions
- Level of participation in live online classes
- Ability to complete and submit assignments on time
- Student's perceived impact of online learning on academic performance

3.3 Secondary Data Collection

Secondary data was gathered from peer-reviewed journals, research articles, and institutional reports on reputable academic platforms such as Google Scholar, ScienceDirect, and ResearchGate.

Additionally, official reports from UNESCO and the World Bank were reviewed to understand broader trends in digital education, internet penetration, and the global impact of COVID-19 on learning systems. These sources offered theoretical grounding and allowed comparisons between the study's findings and existing national and international research.

3.4 Data Analysis

The collected survey data was analyzed using descriptive statistical methods to summarize and interpret the responses effectively. The analysis aimed to identify patterns and relationships between internet access, device availability, and academic performance.

The following analysis techniques were used:

- Frequency and percentage distribution of responses
- Bar charts and pie charts for visual representation
- Comparative analysis between school and college students
- Interpretation of trends related to connectivity quality, participation, and performance
- The analysis aimed to establish clear links between challenges in digital accessibility and educational outcomes during online learning.

3.5 Tools Used

The following tools and platforms were used throughout the study:

- Google Forms for designing and distributing the questionnaire
- Microsoft Excel for data cleaning, tabulation, and statistical analysis
- Microsoft Power BI for advanced visualization and graphical representation of findings
- Academic research databases for secondary data collection and literature support

4. RESULTS AND ANALYSIS

This section presents the analysis of survey responses from 130 students. It examines how internet connectivity and the digital divide affected academic performance during online learning in COVID-19. We used descriptive statistics with percentage distribution. The results are shown in Tables I–VI and Figures 1–6.

1. Demographic Profile of Respondents

Table I. Distribution of Respondents by Education Level

Education Level	Percentage (%)
School students	51.54
College/University students	48.46

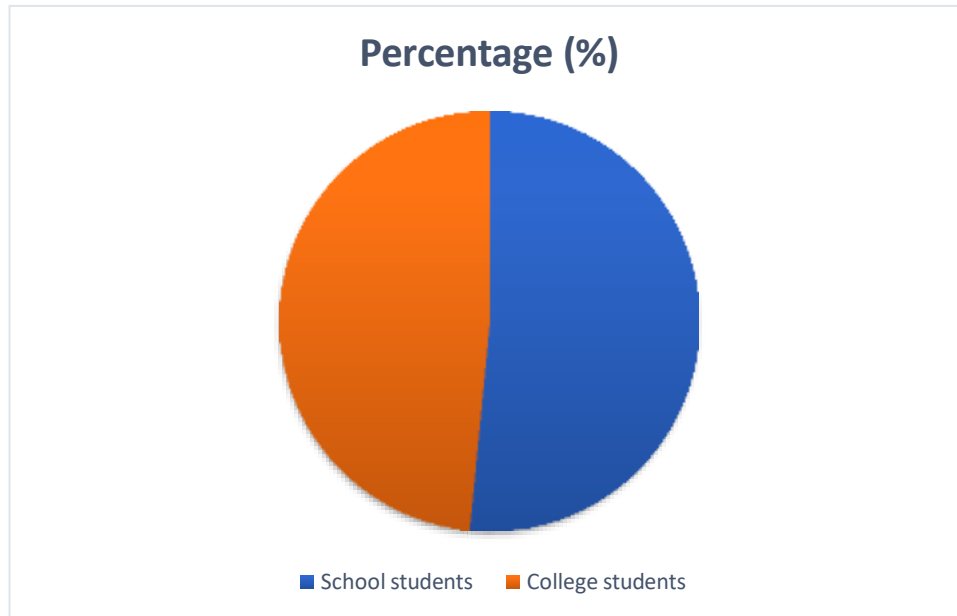


Fig. 1. Distribution of respondents by education level

Analysis:

Table I and Fig. 1 show that the group of respondents was nearly equally divided between school-level and college-level students. This balance improves the reliability of comparisons related to digital access and academic performance across different educational levels.

2. Internet Connectivity Quality

Table II. Internet Connectivity Quality During Online Learning

Internet Quality	Percentage (%)
Very good	16.92
Good	20.00
Average	21.54
Poor	21.54
Very poor	20.00

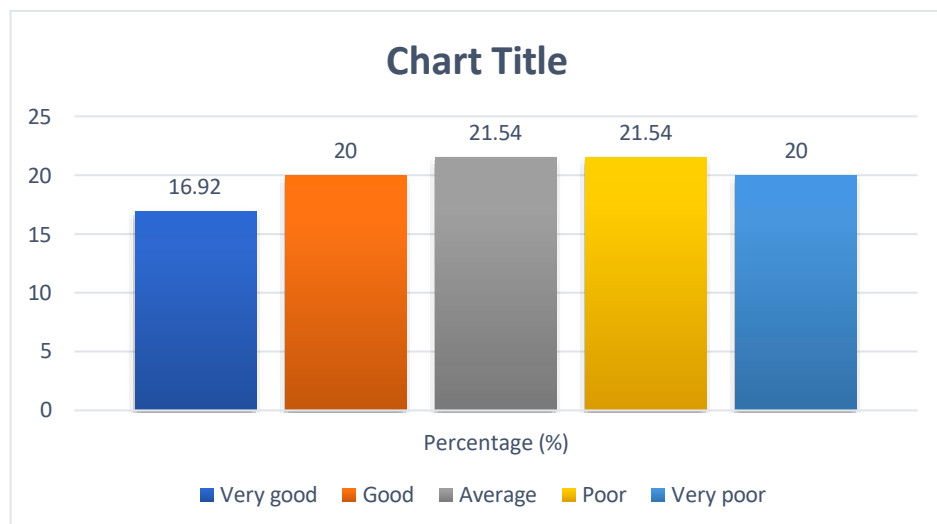


Fig. 2. Internet connectivity quality experienced by students during online learning

Analysis:

As shown in Table II and Fig. 2, 63.08% of respondents faced average to very poor internet connectivity. This highlights the common issue of unstable networks during online learning, which negatively impacted class attendance, access to materials, and participation in real-time learning activities.

3. Digital Device Usage

Table III. Primary Digital Devices Used for Online Learning

Device Used	Percentage (%)
Laptop	30.77
Smartphone	24.62
Desktop computer	23.08
Tablet	21.54

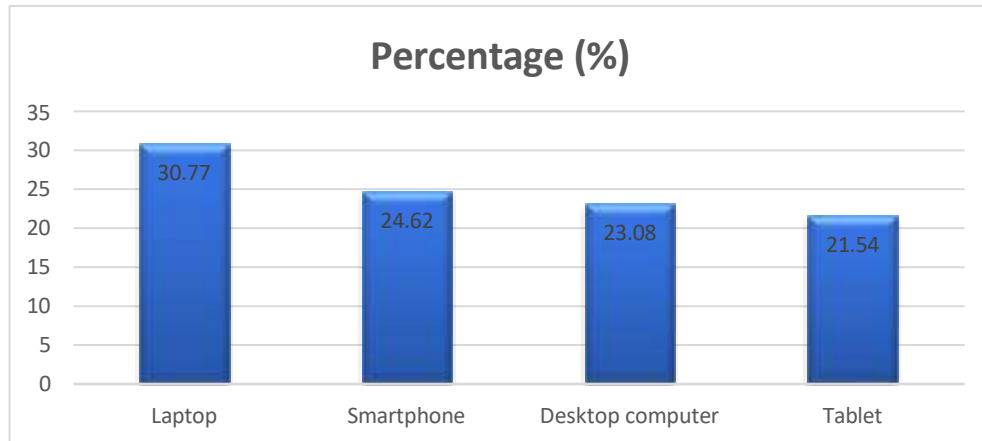


Fig. 3. Primary digital devices used for online learning Analysis:

Table III and Fig. 3 show that laptops were the most commonly used devices. However, nearly one-fourth of students depended on smartphones for their studies. While smartphones are accessible, they have drawbacks like smaller screens, higher data usage, and limited functionality, which can hurt sustained learning and assessment performance.

4. Change in Academic Performance Compared to Physical Classes

Table IV. Overall Change in Academic Performance During COVID-19 Online Learning

Academic Change	Performance	Percentage (%)
Improved significantly		21.54
Improved slightly		14.62
No change		23.85
Declined slightly		19.23
Declined significantly		20.77

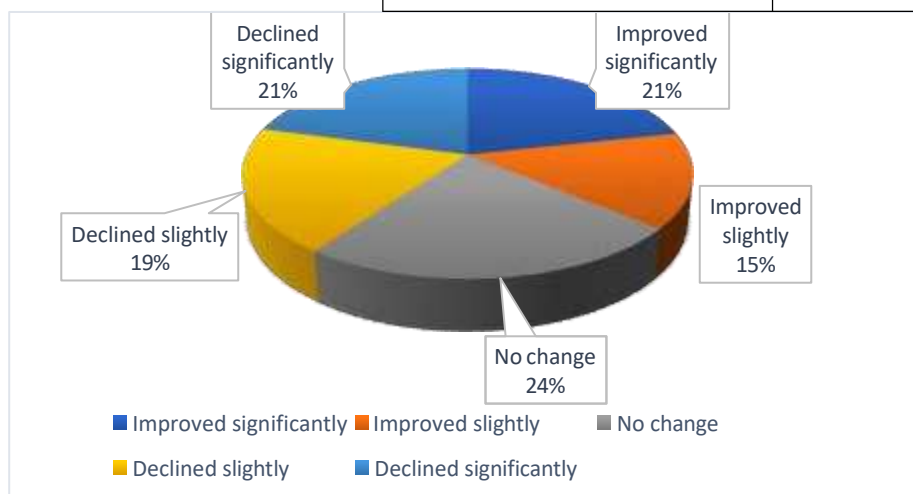


Fig. 4. Overall Change in Academic Performance During COVID-19 Online Learning

Analysis:

Table IV and Fig. 4 show that 39.99% of students experienced a drop in academic performance, while only 36.16% reported an improvement. These results suggest that online learning was less effective than classroom learning for many students, especially those dealing with digital access issues.

5. Perceived Effectiveness of Online Learning Table V. Perceived Effectiveness of Online Learning

Online Learning Effectiveness	Percentage (%)
Very effective	27.69
Effective	18.46
Moderately effective	14.62
Ineffective	23.85
Very ineffective	15.38

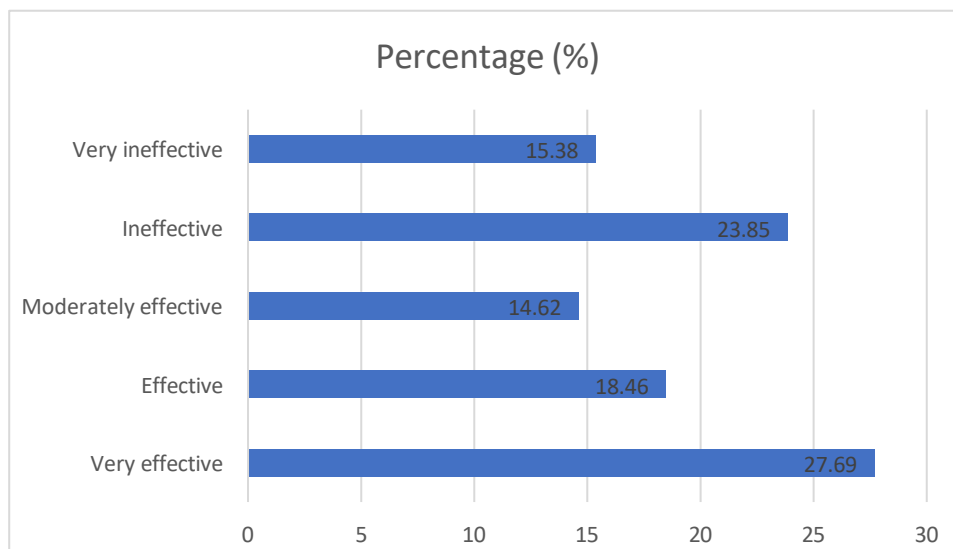


Fig. 5. Perceived Effectiveness of Online Learning

Analysis:

According to Table V and Fig. 5, 39.23% of respondents viewed online learning as ineffective or very ineffective. This perception highlights issues related to unstable internet, limited interaction, and insufficient digital resources, which lowered the overall learning experience.

6. Academic Performance Comparison Before and During COVID-19

Table VI. Comparison of Students' Academic Performance Before and During COVID-19

Academic Performance Comparison	Number of Students	Percentage (%)
Same in both modes	41	31.54
Not sure / Cannot compare	32	24.62
Better during online learning	29	22.31
Better in physical classes	28	21.54

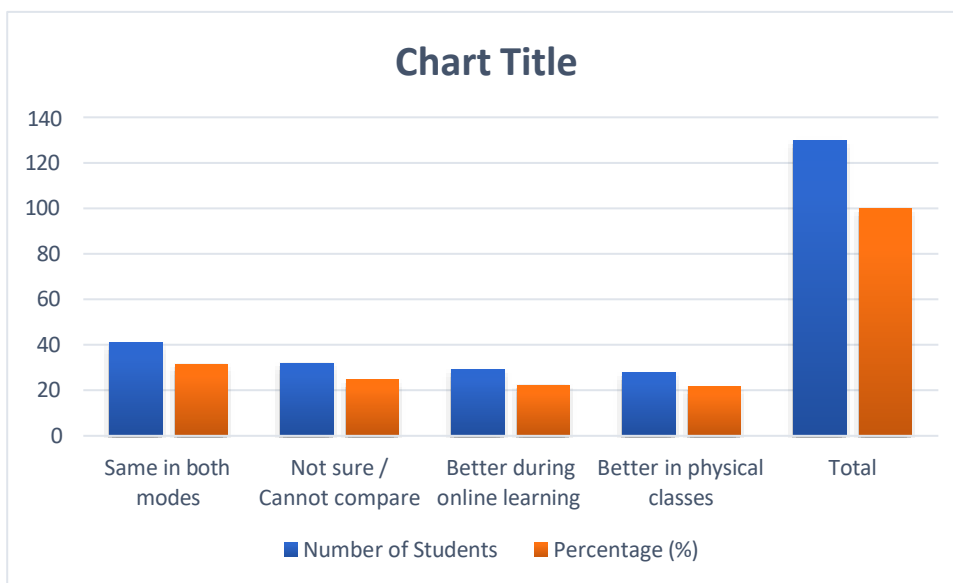


Fig 6. Comparison of Students' Academic Performance Before and During COVID-19 Analysis:

The data shows that 31.54% of students reported no change in academic performance between physical and online learning modes. This indicates that nearly one-third adjusted equally well to both systems. About 24.62% of respondents were unsure or could not compare their performance. Meanwhile, 22.31% said their performance improved during online learning. In contrast, 21.54% reported better performance in physical classes. Overall, the results suggest that students' experiences varied, with no single mode of learning being clearly better.

5. INTERPRETATION

The results show that internet connectivity and digital access significantly influenced students' academic performance during COVID-19-related online learning. Many students reported experiencing average to poor internet quality, which led to frequent disruptions in live classes, less interaction with instructors, and difficulties accessing learning materials.

Students who relied on mobile data and smartphones faced greater academic challenges than those with stable broadband connections and laptops. Limited data availability, sharing devices, and technical issues harmed class attendance, assignment completion, and exam performance. As a result, many students reported a drop in academic performance during the online learning period compared to in-person classrooms.

Overall, the findings suggest that the digital divide significantly impacted learning outcomes during the pandemic. Unequal access to reliable internet and appropriate digital devices reduced the effectiveness of online education and contributed to differences in academic performance among students.

6. DISCUSSION OF FINDINGS

The findings from this study show that internet connectivity and digital access significantly affected students' academic performance during COVID-19 online learning. Many students faced average to poor internet quality, which disrupted live classes and limited effective participation. Unstable networks hindered access to learning materials and negatively impacted student–teacher interaction.

Device availability also affected learning outcomes. Laptops were the most commonly used devices, but many students depended on smartphones, which are not ideal for long academic activities. Relying on smartphones made it harder to attend classes, complete assignments, and participate in assessments.

Almost two-fifths of the respondents reported a drop in academic performance during online learning, highlighting the issues with emergency remote education. While some students adapted well and showed improvement, the advantages were not shared equally. Differences in internet reliability, access to devices, and digital skills largely explain these varied experiences.

Students' views on the effectiveness of online learning further support these findings. A significant number rated it as ineffective. Limited interaction, technical problems, and a lack of structured learning environments reduced motivation and understanding. Overall, the study confirms that the digital divide significantly influenced learning outcomes and emphasizes the need for better infrastructure, affordable devices, and digital skills training to support effective online and blended learning in the future.

7. CONCLUSION

The COVID-19 pandemic caused a quick shift from traditional classroom teaching to online learning. This shift brought significant changes to the education system. This study looked at how internet connectivity and the digital divide affected students' academic performance during remote learning due to COVID-19 by analysing survey responses from students.

The findings show that while online learning helped maintain educational continuity during the pandemic, it was not equally effective for all students. Many learners dealt with unstable internet connections, limited data access, and a heavy reliance on smartphones. These issues disrupted attendance in live classes, understanding of course material, and timely completion of assignments, which reduced overall learning effectiveness.

The results further indicate that a significant number of students reported no improvement or even a decline in academic performance compared to physical classroom learning. Students with reliable internet access and personal digital devices showed better engagement and academic outcomes. This highlights the importance of internet quality and device suitability in online education.

The study also reveals clear digital gaps between school and college students, with school students facing more connectivity challenges. These inequalities negatively impacted participation, engagement, and learning outcomes, reinforcing the effects of the digital divide on academic performance.

In conclusion, the findings indicate that access to technology alone is insufficient without reliable connectivity and adequate digital support. Reliable internet connectivity, availability of suitable devices, and reducing digital inequalities are essential for creating inclusive and effective online education systems. Improving digital infrastructure, making internet services and devices more affordable, and boosting digital skills are critical steps to lessen educational inequalities and better prepare education systems for future challenges.

8. FUTURE SCOPE

This study shows how internet connectivity influenced students' learning during the COVID-19 pandemic. There is room for more research to gain deeper insights into the digital divide and its long-term effects on education. Future studies can increase the sample size, include different regions, and look for practical ways to reduce digital inequality.

The following areas can be considered for future research:

- Include a larger and more diverse group of students from various regions and economic backgrounds.
- Combine surveys with interviews or discussions to capture real-life experiences.
- Conduct long-term studies to see how digital skills and academic performance change over time.
- Examine how well blended learning (a mix of online and offline) works.
- Evaluate government digital education programs and their actual effects.
- Explore affordable solutions like low-cost devices and better internet infrastructure to reduce inequality.

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