Exploring the future of edtech and the COVID-19 impact on digital learning in Bangladesh: A predictive analysis using EDA and regression analysis

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ABSTRACT

Digital learning has become an important component of the educational landscape in Bangladesh, and this study examines how it has affected Bangladesh, with a particular emphasis on the changes brought about by the COVID-19 pandemic. As a result of the epidemic, the number of e-learning platforms has increased significantly. The long-term viability of these e-learning platforms for academic and personal growth has raised concerns. We conducted a survey among 243 high school, university, and graduate students to collect a series of relevant data, evaluate the changes COVID-19 brings to the education sector, and gather the opinions and interests of students in Bangladesh towards e-learning platforms. In order to conduct a study of the data, both regression analysis and exploratory data analysis (EDA) were utilized. The findings pointed to a number of significant variables that affect digital education, including learning experiences, skill development, and accessibility. The results shed light on possible obstacles and prospects for e-learning in Bangladesh and offer insights into its future. We provide a number of recommendations for the efficient and sustainable growth of digital learning platforms, emphasizing the need for improved digital skills, improved infrastructure, and ongoing support for both teachers and students.

Keywords: *Bangladesh, COVID-19, Digital learning, EdTech, E-Learning, Regression analysis.*

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Highlights of this paper:

- This study explores the impact of digital learning on the education sector, highlighting changes due to COVID-19 and the rise of e-learning platforms.
- It reveals that online learning has more potential than face-to-face learning, significantly enhancing learning experiences, skill development, and accessibility, with Higher Secondary Certificate (HSC) and admission candidates being the primary users of ed-tech platforms.
- Future implications include the need for better digital skills, improved infrastructure, increased support, enhanced Bengali content, and local ed-tech collaborations.

1. INTRODUCTION

Emergency situations may cause a disruption in educational pursuits (Bragg, Walsh, & Heyeres, 2021). Despite the global popularity of technology-enhanced learning for many years, the COVID-19 pandemic has brought about a paradigm shift in the conduct of teaching and learning (Chaudhary & Sathe, 2023). Around mid-April 2020, schools and other institutions in every country closed because of the epidemic, which affected approximately 1.57 billion students (UNESCO, 2020). For decades, technology has been a part of the educational landscape, and one could argue that chalk and blackboards, as well as books, are types of technology appropriate for learning (Fekadu, Lipon, Mohiul, Anisul, & Sujit, 2024; Williamson, 2022). The term "EdTech" refers to a broad field that includes both business and technology (Salta, Paschalidou, Tsetseri, & Koulougliotis, 2022). "Edtech" encompasses an extensive variety of actors (both human and non-human), organizations (public, private, or multisector), materials, technical forms, practices, and discourses, as well as a wide range of research, development, and critical inquiry fields (Salta et al., 2022). The Covid-19 pandemic has prompted a shift in the educational landscape from traditional classrooms to online learning (Barron Rodriguez, Cobo, Muñoz-Najar, & Ciarrusta, 2020). As the use of technology in education has increased, a significant part of EdTech's success is based on how it improves students' learning outcomes in classrooms supported by EdTech and fully online learning environments, where basic access (such as to a reliable network connection and to laptop computers or smartphones) is indirectly presumed (Khan, Vivek, Khojah, & Tahir, 2021). The coronavirus outbreak resulted in lockdowns in numerous countries, including Bangladesh, with serious consequences for daily life. The closure of educational facilities by March 17 led to an immediate decrease in Bangladesh's student population (Hossain, 2020). The use of digital learning has allowed schools and colleges in Bangladesh to continue providing education to their students despite the challenges posed by the pandemic (Williamson & Hogan, 2021). Students in Bangladesh have been able to continue their education throughout the pandemic thanks to digital learning tools like live online classes, recorded video lectures on social media, and educational apps, while ed tech startups provide a range of services like online courses, test preparation, and career guidance to help them access quality education and acquire new skills (Noor & Shaoun, 2021). According to a report by the Bangladesh Bureau of Educational Information and Statistics (BANBEIS), as of September 2021, around 26,840 primary schools, 4126 secondary schools, and 2338 higher secondary schools were providing education through digital platforms in Bangladesh. Additionally, the “Amar Ghore Amar School” (My School in My House) initiative had reached over 22 million students across the country (Williamson, 2021). 10 Minute School is considered the first ed tech platform in Bangladesh, and it has been providing students with online education and learning materials for several years. However, when the COVID-19 pandemic hit the education sector, several other ed tech platforms emerged to take advantage of the opportunity to provide remote learning and education services to students.

Leading multinational tech giants like Google, Alibaba, and Microsoft have emerged as crucial distant education infrastructures, while international organizations like the Organization for Economic Co-operation and Development (OECD), World Bank, and UNESCO have aided the growth of edtech globally, supported by significant think tanks and consultancies (Williamson & Hogan, 2021). To lessen the disruption brought on by the pandemic and to devise

strategies for creating more adaptable and open educational systems in the future, we must investigate the implications and repercussions of the proliferation of digital technology in education (Grincheva, 2022). Commercial, governmental, public sector, and cross-sectoral coalitions have convened around edtech as both a short-term solution to the pandemic and a long-term vision for post-pandemic educational reconstruction (Zubairi, Kreimeia, Kaye, & Ashlee, 2021). Since the pandemic, there has been such a significant surge in technology-supported learning that experts anticipate a permanent transformation in the nature and delivery of education (Ghosh & Das, 2022; Hira & Anderson, 2021).

This study examines the effects of digital learning in Bangladesh (BD), emphasizing the changes brought about by the COVID-19 pandemic. The study also explores the potential growth prospects and potential obstacles for e-learning platforms in Bangladesh. We examined the collected data for their future implications using exploratory data analysis (EDA) and regression analysis.

2. LITERATURE REVIEW

This study aims to analyse data from e-learning platforms and students' changes in perceptions to prove the hypothesis that COVID-19 brought revolutionary changes in digital learning in Bangladesh, and to predict the future of EdTech and digital learning in Bangladesh because of the significant changes that occurred during the pandemic. Akour, Alshurideh, Al Kurdi, Al Ali, and Salloum (2021) used machine learning techniques to analyse a Twitter dataset specific to South Korea during the epidemic to investigate the effects of Covid-19 on that country and uncover emerging problems by analysing the sentiments and stress of students and educators. They investigated the shift in public perception of the pandemic from positive to negative feelings, encompassing issues such as access to courses, online assistance, and the influence on mental health, employment, students, and institutions. According to Liu and Yu (2023), E-learning technologies have significantly transformed conventional teaching and learning approaches by providing improved accessibility to knowledge and interactive resources across all educational levels. A study by Almaiah and Almulhem (2018) found that while remote learning can be advantageous during a pandemic, technological adoption can impact learning approaches and availability. The study aimed to guide educators and learners who were new to using technology for teaching and learning. They also attempted to develop a hybrid model to identify the anxieties of learners and instructors during the epidemic. As a result of the COVID-19 pandemic, educational institutions worldwide used e-learning solutions to maintain the flow of education while reducing the chances of virus spread (Cuisia-Villanueva & Núñez, 2021). The purpose of this rapid change was to mitigate the risk of mass gatherings, which presented substantial health risks (Amir et al., 2020). Due to pandemic procedures, students and instructors globally transitioned to remote work, utilizing different online platforms such as Google Meets, Microsoft Teams, Zoom, and Moodle-based learning systems (Amir et al., 2020).

Table 1. Information of Edtech company in Bangladesh.

Edtech company	Launch date	Pre/Post COVID-19
10 minute school	2015	Pre-COVID
Amar Pathshala	2020	Post-COVID
Edvive	2020	Post-COVID
Eduhive	2018	Pre-COVID
Shikho technologies	2019	Post-COVID
Sohopathi	2017	Pre-COVID
Thrive	2019	Pre-COVID
Upskill	2018	Pre-COVID

Source: Websites of these eLearning platforms.

As the COVID-19 pandemic hit the education sector, several other ed tech platforms emerged to take advantage of the opportunity to provide remote learning and education services to students. Here's Table 1, which presents some information about some popular EdTech companies in Bangladesh, including their launch dates and whether they were founded before or after COVID-19.

Bangladesh's potential for online education in the modern era and the value of using the internet for learning and education were examined. Laufer et al. (2021) and Katyeudo and de Souza (2022) highlighted projects, issues, and suggestions for putting e-learning into practice in Bangladesh. The objective is to assist the nation in surviving in a modern, cutthroat environment. Rodrigues, Almeida, Figueiredo, and Lopes (2019) intend to develop expertise in cognitive, social, logical, interpersonal, technological, and technical skills, among others, in response to the needs of the Fourth Industrial Revolution and global challenges, such as mitigating the causes and effects of climate change based on people's awareness. The survey looked at the opinions of 2196 students from 29 Austrian universities to see whether they preferred online learning or more traditional face-to-face instruction (Paechter & Maier, 2010). According to Alzahrani (2022) online learning is significant as it saves a large amount of time and creates an environment where students can also learn from home. To maximize learning outcomes, this study suggests a mixed learning strategy that incorporates online and in-person components. Students propose employing online learning for information transmission and face-to-face learning for cooperative scenarios. However, they critique online education for helping students learn concepts and procedures. According to the study, this could be because e-learning courses don't have enough interactive learning content. The article discusses the impact of COVID-19 on the Indian educational system, specifically the challenges faced by teachers in providing online education (Jain, Lall, & Singh, 2013). The three-gap approach is used to analyze the disparities in educational access, usage, and abilities. The introduction of online learning has widened the divide between private and public schools, making it harder to reach economically disadvantaged students. The article highlights the need for additional teacher preparation in online pedagogies and the role of Ed-Tech businesses in filling this gap. However, there is a question of whether these solutions will benefit hard-to-reach students. The article emphasizes the importance of providing proper training and support for teachers to deliver high-quality instruction in online environments, which may become more prevalent in the future. The study emphasizes the significance of assessing students' perceptions of and readiness for the online learning environment implemented at the university level in the aftermath of the COVID-19 epidemic, where computer-based learning replaces traditional teaching methods and face-to-face interaction. According to the study's findings, students had an optimistic view of e-learning and its relevance during the COVID-19 crisis, showing social media's potential to improve learning. These results will assist academic institutions and policymakers in developing and improving online learning strategies (Khan, Rahman, & Islam, 2021).

3. METHODOLOGY

3.1. Research Design

This study's research design combines qualitative content analysis and quantitative survey methods to evaluate the Future of EdTech and Covid-19's impact on Digital Learning in Bangladesh.

Qualitative Approach: For the qualitative component, the feedback from multiple Bangladeshi e-learning sites' Play Store apps was subjected to a content analysis. This method aimed to understand the overall perspective of students towards these applications. We examined 100 reviews in total to identify recurring themes and emotions. The insights this qualitative content analysis offers into the experiences and perceptions of the students help identify the advantages and disadvantages of the present e-learning platforms.

Quantitative Approach: A quantitative survey for data collection was designed in Google Form format and conducted online, with sampling based on a voluntary sampling method. The resulting sample comprises 243 students. For this questionnaire, we analyzed two categories of students in Bangladesh: university students (graduate and undergraduate students) and college students (classes 11 and 12 and students who passed the Higher Secondary School Certificate exam). We conducted this questionnaire in April 2023 to explore various issues, such as revealing students' experiences of distance learning during the COVID-19 pandemic. This approach makes it possible to cover several colleges (high schools) and universities with a sample of 243 respondents. The resulting sample comprises 47.6% university students (29.3% undergraduate and 18.3% graduate), 8.9% university admission candidates, and 43.5% college students (or high school students).

3.2. Research Population

In this study, the online survey was conducted with semi-structured questionnaires. Online survey is one of the best ways to reduce costs when conducting a study, but it is also an effective way to get real data from the online population Aiyanyo, Samuel, and Lim (2021). A total of 243 respondents from several high schools and universities in Bangladesh participated in this survey, with the majority of the population being from Chittagong.

Participants Selection and Sampling Method: The selection process for participants used voluntary sampling. Social media, student organizations, and networks within educational institutions were used to invite people to participate in the study. This approach was used to guarantee a representative and diverse sample of Bangladeshi students.

Based on their educational status, this study divided respondents into four categories: admission candidates, college students, undergraduate students, and graduate students. Admission applicants are those preparing to attend university, whereas college students are those studying in classes 11 and 12 or who have recently passed the Higher Secondary School Certificate exam. Undergraduate students are seeking their first degree at a university, whereas graduate students have finished their undergraduate studies and are pursuing higher degrees. This classification provides a full depiction of the respondents' educational levels. Table 2 displays demographic information regarding the distribution of respondents among different participant categories, ensuring that the study sample composition is understood clearly and accurately.

3.2.1. Demographic Information

Table 2 presents demographic information about the respondents participating in this study, providing insights into gender distribution among the participants.

Table 2. Gender distribution of the participants.

Gender	Participants	Count of percentage
Female	140	58%
Male	103	42%
Total	243	100%

Table 3 provides information about the distribution of respondents among the four participant categories to offer a comprehensive understanding of the study population.

Table 3. Distribution of respondents by educational background.

Current study status	Count of current study status
Admission candidate	8.64%
College student	36.21%
Graduate	17.70%
Undergraduate	37.45%
Grand total	100.00%

According to Table 2, previously mentioned, 58% of the sample respondents were female and 42% were male. Table 2 also displays the educational background of the respondents. 37.45% of respondents are undergraduates, 36.21% are college students, 8.64% are admissions candidates, and 17.7% are graduates.

3.3. Instrument

We used Google Forms for data collection because of its easy-to-use interface and remote accessibility. Our survey instrument was carefully constructed to collect qualitative and quantitative data relevant to our research objectives. In addition to quantitative insights, open-ended replies were analyzed qualitatively to uncover developing themes and trends. During the quantitative analysis phase, Python and Excel were used because of their ability to manage datasets and execute statistical studies. In addition, we used Exploratory Data Analysis (EDA) to acquire preliminary insights and visualized the results to better comprehend the data distribution. Statistical analyses were then used to analyze the current status of the study samples, providing useful information about our research findings.

3.4. Validity and Reliability Test

The use of technology in Bangladesh's education sector has always been a great challenge for the government, as the availability of internet connections and a lack of computer literacy have been major barriers. We must contend with sustainable network facilities and a shortage of devices. Despite the significant decrease in the price of mobile phone devices, the availability of such facilities remains severely limited. In our paper to find a solution, we conducted a survey to collect data, and the targeted population is intermediate and university students.

There are 6 hypotheses.

1. Digital learning is a blessing for us, as its usage can bring revolution and give us expertise to compete globally.
2. Since more eLearning resources have become available since the pandemic, students who have finished courses on a particular topic on a digital platform have an in-depth understanding of that topic.
3. Digital learning using EdTech improves the learning environment and has the potential to replace traditional classroom instruction.
4. Technical problems on an e-learning platform positively correlate with the belief that EdTech can bridge the knowledge gap for students from disadvantaged backgrounds.
5. Learners who became dependent on eLearning platforms during the COVID-19 pandemic think that their academic performance has improved.
6. People who became dependent on the eLearning platforms during COVID have completed most of the courses.

4. DATA ANALYSIS AND DISCUSSION

The data were analyzed by the Explanatory Data Analysis method using Python. Overall, the data of this study converged by comparing the questions that appeared in the questionnaires and setting some variables. For our

findings, we mainly focus on the qualitative data as these provide more context and explanation. Quantitative approaches were used for Q6, Q7, and Q11 .

4.1. Quantitative Questions

Q6: How many courses have you completely finished from BD E-learning Platforms during COVID-19?(Open answer)

Q7: Do you prefer paid or free courses? If you prefer paid courses, what is the highest number of paid courses that you have purchased from an e-learning platform? (Open answer)

Q11: How many hours a day do you use your devices for study purposes? (Open Answer)

4.1.1. Perception About Educational Technology

The variable referred to as perception about educational technology was constructed by the following items: Q5, Q14, Q19, Q20, and Q21.

Q5: The use of technology can bring about a revolution in the education sector and enable one to compete globally. Which option describes you best? (Strongly disagree, Somewhat disagree, Neutral, Somewhat agree, Strongly agree)

Q20: Digital Learning is a blessing for us. Which option describes you most? (Strongly disagree, Somewhat disagree, Neutral, Somewhat agree, Strongly agree).

The following table provides a comparative analysis between the above-mentioned questions (Q5 and Q20)

Table 4. Comparative analysis between Q5 , Q20.

Opinion	Usage of technology can bring revolution in education sector and can expertise one to compete globally	Digital learning is a blessing for us
Strongly agree	127 (52.26%)	97 (39.92%)
Strongly disagree	6 (2.47%)	7 (2.88%)
Neutral or others	110 (45.27%)	139 (57.2%)

In Table 4, we compare Q5 and Q20. Here, 39.92% of the people who attended the survey strongly agreed that digital learning is a blessing. In contrast, 139 participants are neutral.127 respondents believe that by using technology, people can obtain knowledge in their field of interest and compete on a worldwide scale. Perhaps they are committed to the complete implementation of educational technologies.

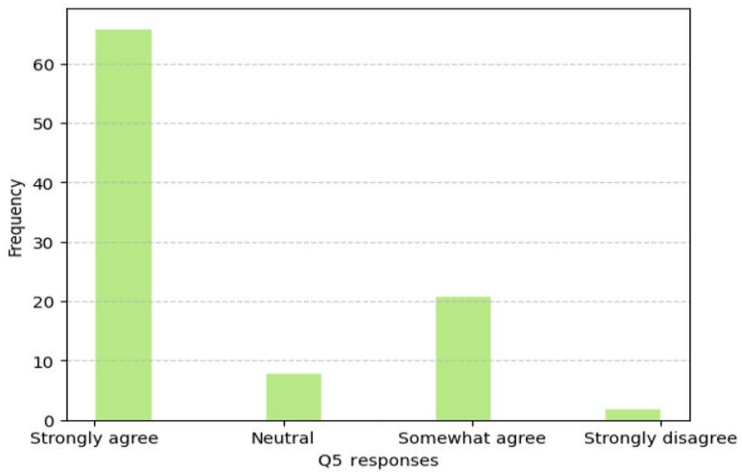

Figure 1. 'Q5 responses for 'Strongly agree' in Q20.

The analysis in Figure 1. shows that the majority respondents think that digital learning is beneficial and even a blessing. They believe that digital learning has the potential to revolutionize education and provide people with the skills they need to compete on a global basis. These findings verify hypothesis 1, which contends that digital learning has a positive effect on empowering students and boosting their competitiveness on the international stage.

Q14- The availability of e-learning materials (course, pdf, etc.) has increased since the time of the COVID-19 pandemic. In that case, what is your opinion ? (Strongly disagree ,Somewhat disagree, Neutral, Somewhat agree, Strongly agree).

Q19- By completing a course on a digital learning platform, your idea about that topic was cleared perfectly. Which option describes you most? (Strongly disagree ,Somewhat disagree,Neutral,Somewhat agree,Strongly Agree, I am unsure).

Question 14 shows an important change in the reach of e-learning materials since the epidemic, with 87.7% of respondents (strongly agree and somewhat agree) noticing a rise. This development is likely due to the increased adoption of digital learning tools as educational institutions and organizations respond to lockdowns and social distancing techniques. They need to continue their education remotely, prompted by the rapid rise of online courses, webinars, digital textbooks, and other e-learning resources.

The 7.8% neutral responses may indicate that a few individuals did not notice a major change, either because they already had easy access to e-learning materials prior to the epidemic or because they did not need such resources. Places with insufficient internet connectivity or technological infrastructure may explain the disagreement (4.5% somewhat or strongly disagree), making it impossible for these individuals to benefit from the increase in e-learning availability.

Overall, the broad consensus demonstrates an impactful trend in digital education accessibility, promoting greater learning flexibility and helping to mainstream online education as a viable alternative to traditional classroom settings. We anticipate long-term benefits from this transition, such as increased educational inclusion and creativity.

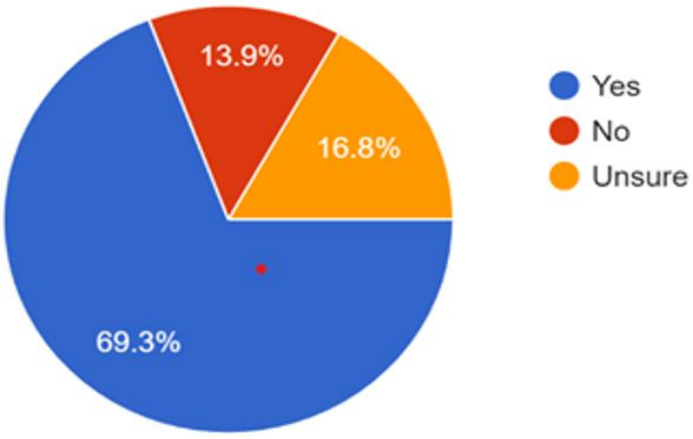

Figure 2. Improvements in academic performance using educational technology.

According to Figure 2, 69.3% of respondents felt that educational technology had helped them do better academically. This good attitude is likely due to the numerous significant benefits provided by educational technology. For starters, it offers customized educational experiences, allowing students to learn at their own pace and tailored to their specific needs. Interactive tools and multimedia resources can help to engage students while strengthening their grasp of complex ideas. Furthermore, educational technology provides access to a wide range of resources and information, promoting varied learning styles and increasing research abilities. The 13.9% who fail to recognize

benefits may be dealing with issues such as a lack of access to technology, insufficient training on how to successfully use these tools, or distractions generated by digital devices. Some educators and students may struggle to move from traditional methods to digital learning settings, which can influence perceived efficacy.

The 16.8% of respondents who are unsure may be a reflection of the inconsistent results observed in various studies. While educational technology can provide major benefits, its performance is frequently dependent on factors such as implementation quality, instructor expertise, and student engagement. Inconsistent outcomes across contexts and populations can lead to confusion about the overall impact on academic performance. To summarize, while the majority acknowledge the favorable influence of educational technology on academic achievement, it is critical to solve the issues and ensure fair access and effective use in order to maximize its benefits.

Perhaps the correlation between the enhanced accessibility of e-learning resources (Question 14) and the enhanced comprehension of subjects via digital platforms (Question 19) supports Hypothesis 2. The results indicate that the increase in available e-learning materials during the pandemic (as strongly agreed by 59% of respondents) has enhanced students' accessibility to instructional content. Hence, the significant proportion of students (69.3% strongly agree) who indicate enhanced comprehension after finishing online courses implies that these materials are not only easily available but also highly efficient. This correlation suggests that the greater accessibility of e-learning materials has probably played a role in improving students' comprehension and knowledge of subjects. This supports the hypothesis that the increase in e-learning resources during the pandemic has resulted in improved educational achievements for students.

In Q9, the respondents indicated strong agreement, moderate agreement, strong disagreement, moderate disagreement, and neutrality, while in Q26, the responses were either yes or no.

Table 5. Understanding of certain topic using e-learning platforms.

Opinions	Availability of e-learning materials have increased during COVID-19	Ideas about that topic was cleared perfectly
Strongly agree	143 (58.85%)	74 (30.45%)
Strongly disagree	9 (3.70%)	6 (2.47%)
Neutral or others	91 (37.45%)	163(67.08%)

The COVID-19 epidemic has greatly expanded the range of e-learning resources. This is shown by the fact that Table 5 demonstrates that 143 individuals fully agree with this statement, while only 9 strongly disagree. Furthermore, 37.45% of respondents remain neutral on the subject. Several factors have contributed to the increased availability of e-learning materials. For starters, lockdowns and social distancing techniques required remote study, forcing educational institutions to quickly adopt and extend their internet resources. Second, advances in educational technology (EdTech) have simplified and accelerated the creation and distribution of these products. Platforms such as Zoom, Google Classroom, and various Learning Management Systems (LMS) have become essential for facilitating ongoing education. Finally, collaboration among content developers, publishers, and technology businesses has resulted in an abundance of high-quality, accessible e-learning resources. The information shows a positive trend regarding the importance of grasping EdTech principles. A total of 74 respondents strongly agreed that their opinions on EdTech were fully clear, with only 6 strongly disagreeing. However, a considerable number of respondents, 163, remain neutral on the subject.

This suggests that, while most people are satisfied with the clarity supplied by EdTech, a significant portion of the public may still be unsure or seek additional clarification. This could be due to varied levels of technology

knowledge, variances in learning styles, or a need for more complete training and support. To solve this, educators must continue their professional growth and improve the usability of EdTech interfaces.

Q21: The e-learning platform will be a multidimensional educational platform, and people can smoothly use it without facing difficulties in Bangladesh. Which option describes you best? (Strongly disagree, Somewhat disagree, Neutral, Somewhat agree, Strongly agree)

Table 6. Responses of students on Q21.

Opinion	Count of 21	Percentage
Strongly agree	47	19.34%
Strongly disagree	24	9.88%
Neutral or others	172	70.78%

The goal of Bangladesh's e-learning platform is to develop into a flexible learning tool that users can easily navigate. According to Table 6, of the 243 responses, 47 strongly agree with the statement, 24 strongly disagree, and 172 are neutral. Multiple factors contribute to this positive outlook. To start, Bangladesh's increasing smartphone and internet adoption makes digital education more accessible. Second, government initiatives and collaborations with technology businesses are improving the infrastructure required for effective e-learning platforms. Third, learning institutions' adaptability and resilience during the COVID-19 epidemic provided a solid platform for future developments. Furthermore, Bangladesh's cultural and linguistic environment-suited local content production enhances user engagement and comprehension. Finally, continual training and assistance for both instructors and students are critical to overcoming initial challenges and ensuring the smooth operation of these platforms.

4.2. Comparison of Traditional and Digital Learning

The variable referred to as Comparison of Traditional and Digital Learning was constructed by the following items: Q9 and Q26.

Q9- "Digital learning makes the learning environment better than the traditional learning environment." Which option describes you best? (Strongly disagree, Somewhat disagree, Neutral, Somewhat agree, Strongly agree)

Q26- Do you think EdTech can replace traditional classroom learning? (Yes , No)

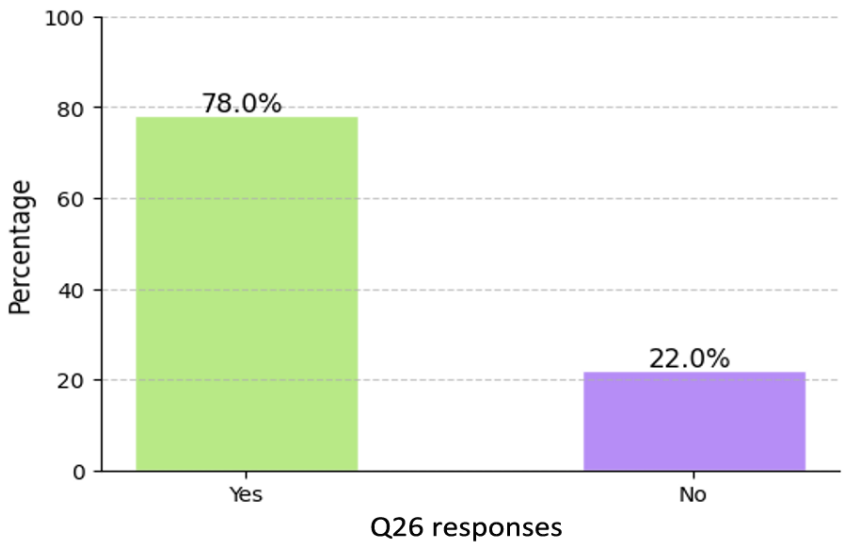

Figure 3. Q26 responses for 'Strongly agree' in Q9.

Figure 3 presents the analysis results for these two questions. Among the learners who strongly agree with the statement "Digital learning makes the learning environment better than the traditional learning environment," approximately 80% believe that EdTech can replace traditional classroom learning, while the remaining learners believe that it cannot. It proves Hypothesis 3.

4.3. Burdensome of Education Technology

The items Q15 and Q16 constituted the variable known as burdensome education technology.

Q15: Have you ever experienced any technical difficulties using an e-learning platform? (Internet Connectivity, High Price of Data, Shortage of Devices, Others).

Q16: Do you believe that EdTech can bridge the education gap for students from disadvantaged backgrounds (e.g., rural areas, bad internet connectivity, etc.)? (Yes , No)

Table 7. Edtech's technical challenges at COVID-19.

Technical difficulties	Count of experienced technical difficulties using e-learning platforms	Percentage
High price of data	41	16.87%
Internet connectivity	151	62.14%
Others	34	13.99%
Shortage of devices	17	7.00%
Grand total	243	100.00%

A recent survey of the challenges consumers face while utilizing edtech platforms revealed that the vast majority of respondents suffer from a variety of obstacles. In Table 7, specifically, 41 respondents, or 16.87% of the participants, mentioned difficulties due to the high cost of data, which can impede constant access to online educational resources. A larger group of 151 participants reported internet connectivity issues, suggesting that unreliable or poor internet connections pose a significant impediment to successful edtech use. Furthermore, 17 respondents cited a lack of data, indicating another aspect of accessibility concerns. Furthermore, 13.99% of those polled reported a variety of challenges, ranging from technical issues to a lack of usable interfaces. These findings illustrate the multifaceted nature of edtech challenges, emphasizing the significance of infrastructure and affordability upgrades to improve the user experience and accessibility.

Table 8. The percentage of Edtech can assist students bridge the achievement gap.

Opinion	Count of EdTech can bridge the education gap for students from disadvantaged backgrounds	Percentage
No	44	18.11%
Yes	199	81.89%
Grand total	243	100.00%

The potential of EdTech to close the education gap for pupils from underprivileged backgrounds is an emotive subject. According to Table 8, 44 students in the study believe EdTech can effectively handle this issue, while 199 disagree. Many students may be dubious about EdTech's ability to bridge this gap for a variety of reasons. First and foremost, many poor kids continue to face huge obstacles to accessing technology and stable internet connections. Without these vital assets, EdTech cannot reach its full potential. Second, both students and their families might not have technological knowledge and support, making it difficult for them to fully engage with online learning resources. Furthermore, the quality of digital information and its relevance to the unique requirements of disadvantaged pupils

can vary greatly, thus restricting its usefulness. Furthermore, the individualized connection and support that many disadvantaged students require may not be effectively met by EdTech alone.

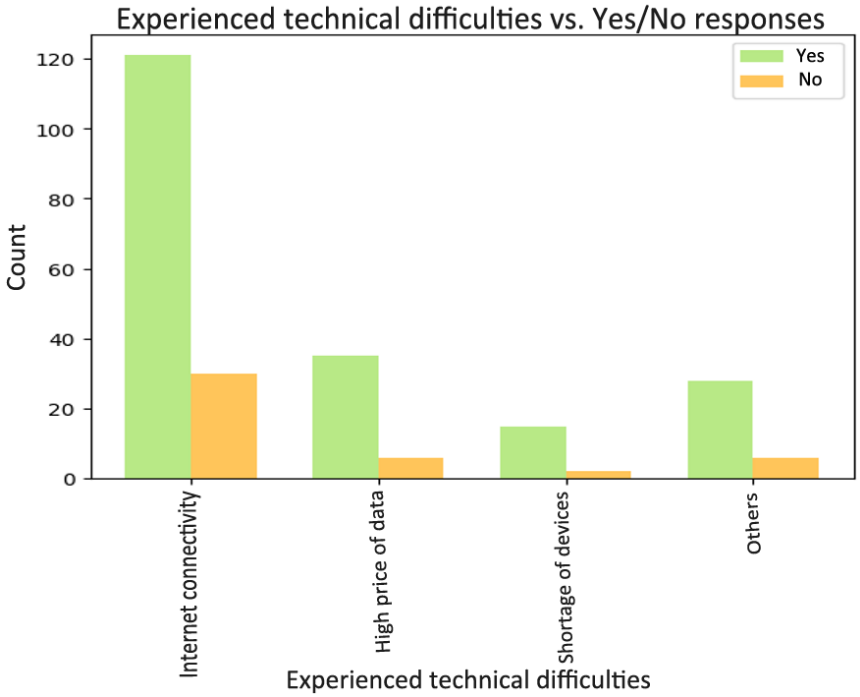

Figure 4. Experienced technical difficulties vs. responses of Q16.

Figure 4 illustrates learners who have encountered technical difficulties when using eLearning platforms, as indicated by their yes or no responses in Q15. This supports Hypothesis 4, demonstrating a clear positive correlation. This may be because learners who faced several technical difficulties believe that focusing on these issues and resolving them can bridge the education gap for students from disadvantaged backgrounds.

4.4. Parental Engagement about Educational Technology

In Bangladesh, the majority of parents view technological devices as unnecessary distractions. Therefore, when the pandemic struck and the use of various technological devices became essential for educational purposes, it became imperative to assess how parents perceived this shift in the mode of education delivery. However, in this case, measuring their perception can play a vital role, as students may not face the barrier of using technology in learning from their parents.

In the survey, the question regarding parents' perceptions was:

Q17: During the lockdown, how did your parents accept this learning process using digital learning platforms? (Positive ,Negative ,Unsure)

The table and graph below display our responses:

Table 9. Parents acceptance about edtech.

Parents acceptance	Count of parents acceptance	Percentage of parents acceptance
Negative	23	10%
Positive	180	74%
Unsure	40	16%
Grand total	243	100%

Table 9 indicates that parent support for EdTech is mainly good, with 180 parents expressing positive views, 23 having negative thoughts, and 40 being unsure. Many factors contribute to the excellent reception. First and foremost, parents appreciate the flexibility and convenience that EdTech provides, allowing their children to learn at their own pace and on their own schedule. Second, increasing access to a variety of resources and interactive information can supplement traditional learning and accommodate different learning styles, potentially boosting educational outcomes. Third, many parents experienced firsthand the value of EdTech in maintaining educational continuity during the closure of physical schools during the COVID-19 pandemic. Furthermore, parents value the opportunity for tailored learning experiences provided by EdTech platforms, which can help better meet individual student requirements. Furthermore, the incorporation of technology into education is consistent with the wider digital shift in society, making parents more likely to support these advancements as critical to their children's future success.

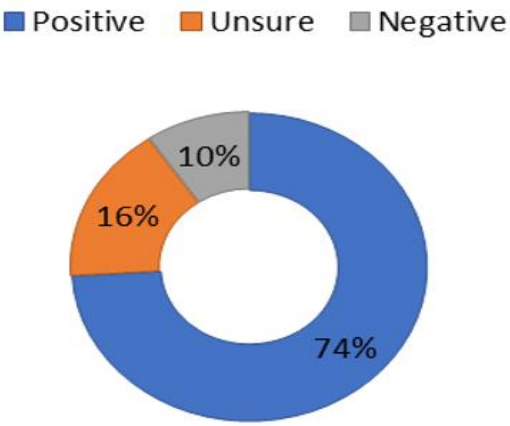

Figure 5. Positive accounts for the majority of "parents acceptance".

As shown in Figure 5, the responses to Q17 indicate that many respondents believe their parents are accepting this change in a positive way. Parents' positive perception of children's eLearning process may play a vital role in the future of digital learning in Bangladesh. In this case, many parents (74%) expressed their positive acceptance of online learning. The reason could be that, as schools, universities, and other educational institutions closed during COVID, students were able to continue their education and maintain their enthusiasm for learning because of digital learning platforms. A significant number (16%) of parents are doubtful about accepting this learning system. There could be various reasons, such as a lack of knowledge about technology or concerns about the quality of education provided by the digital learning platform. A smaller percentage of parents (10%) expressed a negative attitude towards digital learning. This could be due to technical difficulties or network issues. Another reason could be a lack of interaction with teachers and students or a sudden change in traditional learning methods. Overall, most parents are positive about e-learning and digital learning platforms, which highlight their growing popularity and reliability in the future.

The impact of EdTech on Education, both before and after the COVID-19 pandemic, was examined. Given that COVID-19 significantly contributes to the popularity of EdTech in Bangladesh, we included two survey questions to gain a clear understanding of hypothesis 3. The questions are:

Q18- Have you noticed any improvements in academic performance after using the digital learning platforms? (Yes,No,Unsure).

Q23- When did you become dependent on the e-learning platform? (Before Covid-19, At the time of Covid-19, After Covid-19).

After combining these two questions and analyzing the responses, we obtain the following table and bar chart:

Table 10. E-learning platform dependency and academic improvements of students.

Count of time of getting dependent in e-learning platforms	Improvements in academic performance			Grand total
Time of getting dependent in eLearning platforms	Yes	Unsure	No	
At the time of Covid-19	115	32	28	175
Before Covid-19	35	5	1	41
After Covid-19	18	4	5	27
Grand total	168	41	34	243

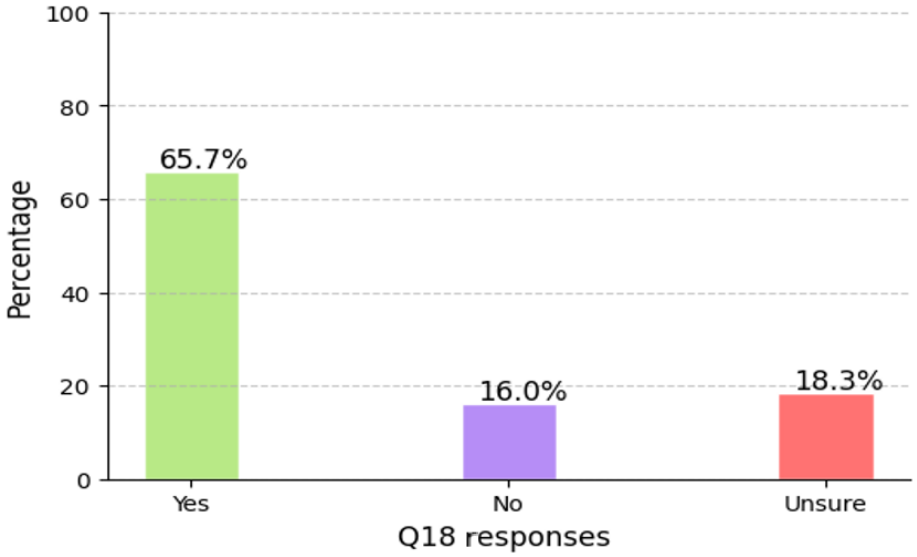

Figure 6. Q18 responses for "At the time of COVID-19" in Q23.

Out of 243 respondents, most (175) started to use online platforms at the time of COVID-19, and we can see that about 66% of the respondents claim they benefited from the use of technology (Figure 6). This implies that the pandemic significantly influenced the use of e-learning platforms. Table 10 offers further insight into this trend, revealing that a significant number of respondents (115 out of 175) expressed a positive attitude towards those who started using digital platforms during the COVID-19 pandemic. Therefore, based on this data, it is reasonable to conclude that a large proportion of students became dependent on the online learning platform during COVID, and among them, many respondents tend to think their academic performance increased due to this, which proved hypothesis 5.

4.5. Preference /Penchant of Edtech Platform

The following items—Q13 and Q22—constructed the variable known as the EdTech platform's preference.

Q13 : Give a rating to the overall e-learning system of Bangladesh (BD). (1,2,3,4,5)

Q22: Which of the following types of platforms is preferred if you are taking a course on an online platform?(BD platform, International Platform, Both, I am unsure).

According to the survey's findings, we prepared a table showing that most students prefer both Bangladesh and international platforms for helping them understand a certain topic Table 11. Our instructional technology is developing every day, but not at the expected rate. On the other hand, international educational technology platforms have the ability to quickly enhance facilities, enrich content, update knowledge, and more, thereby assisting students

in becoming experts on the topics they are researching. Due to their distinctiveness and ability to give well-prepared lectures, there is also a rationale for engaging with worldwide platforms. However, due to the rapid implementation of edtech, we must prioritize the originality of the content and ensure it is updated with appropriate materials.

Table 11. Platform preference among students and their ratings about the edtech.

Count of type of preferred	Overall ratings					Total
Type of platforms preferred	1	2	3	4	5	
Both	13	21	71	24	5	134
International platform	8	17	23	6	1	55
BD platform	4	1	14	7	3	29
I am unsure	2	6	10	7		25
Total	27	45	118	44	9	243

In Table 11 shows that 134 students prefer rating 3, 55 prefer the international platform, 29 prefer the BD platform, and 25 are unsure about their preference. 44.72% of applicants choose the BD platform to prepare them for their admissions examination.

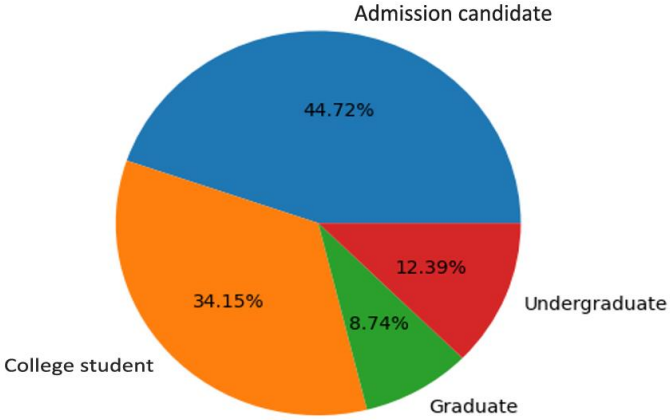

Figure 7. Percentage of Bangladesh platform prefer by each study group.

Here, the college students take 34.15% to prepare for the Higher Secondary Certificate (HSC) examination Figure 7. The percentage of graduate and undergraduate students, however, is not satisfactory due to a lack of available courses, a lack of qualified instructors, a greater emphasis on HSC and college students' content, and other factors.

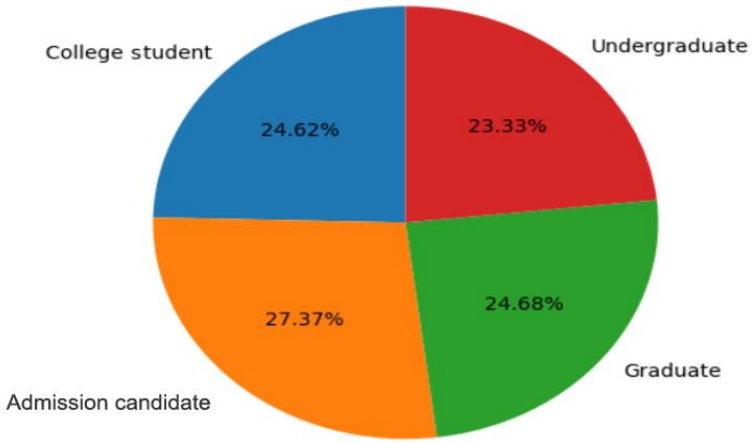

Figure 8. Percentage of both prefer by each study group.

When examining the demographic distribution of students across educational platforms, the percentages show a balanced representation of various groups. In Figure 8, college students account for 24.62% of all users, demonstrating strong participation from those presently pursuing higher education. Higher education institutions enroll 27.37% of admission applicants, indicating widespread use of EdTech platforms by those preparing for their academic careers. Graduates who have finished their higher education account for 24.68% of users, demonstrating the continued need for professional growth and lifetime learning. Finally, undergraduates account for 23.32% of the user base, demonstrating the important role these platforms play in assisting current university students. This distribution demonstrates EdTech's extensive and diverse engagement, nurturing students at all phases of their academic careers.

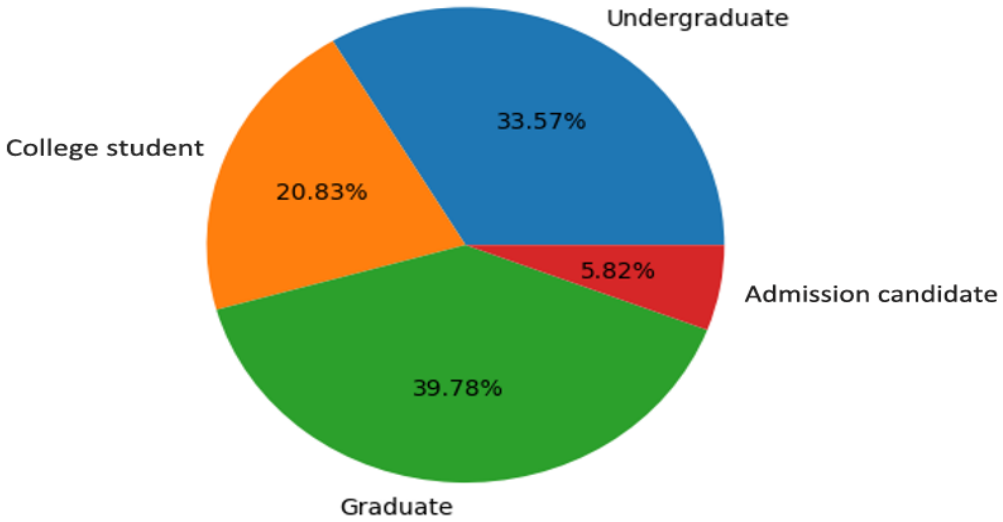

Figure 9. Percentage of international platform prefer by each study group.

If we look, we find that 39.78% and 33.57% of students are using foreign platforms, yet the proportion of applicants for college and admission is not very high Figure 9.

Q13 has been analyzed by Linear Regression Method using the formula y=bx^2+ax+c

Figure 10 and Figure 11 show the following analysis result.

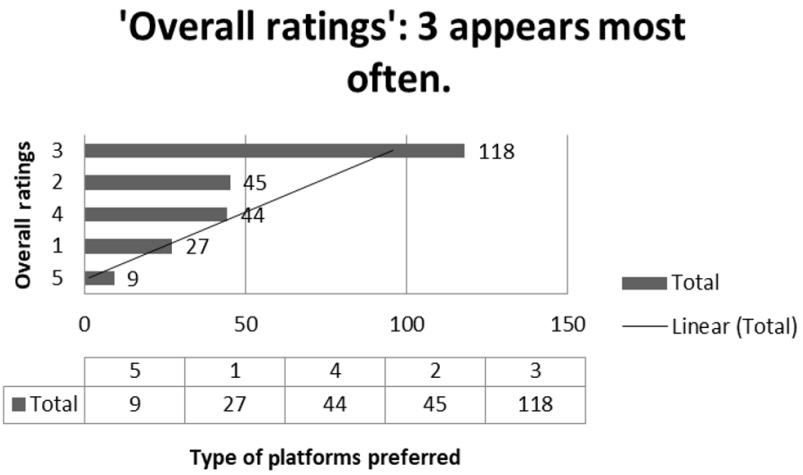

Figure 10. Overall ratings of BD eLearning platforms.

Figure 10 displays the patterns from the Q13 linear regression analysis. The analysis indicates a strong foundation of contentment and acceptance among the participant body, as evidenced by the large percentage of learners (118 votes) who gave the platforms an overall rating of 3. Additionally, the fact that a group of students (9 votes) gave an overall rating of 5 suggests that there is room for additional development and advancement in the field of EdTech. These rankings offer insightful forecasts for Bangladesh's EdTech platforms' future. The engagement of edtech platforms will increase significantly over time if online content instructors pay attention and improve their content for graduate students. However, we have found that the internet's connectivity and speed are extremely poor. The development of internet access infrastructure and the affordability of data and educational technology products are crucial for engaging more students. It's a positive sign that more parents have come to understand the benefits of e-learning for education. During COVID-19, 115 students believed that e-learning was a necessary tool for their education, and 17 students continued to feel this way after COVID-19. It shows a promising trajectory for individuals considering starting an edtech platform.

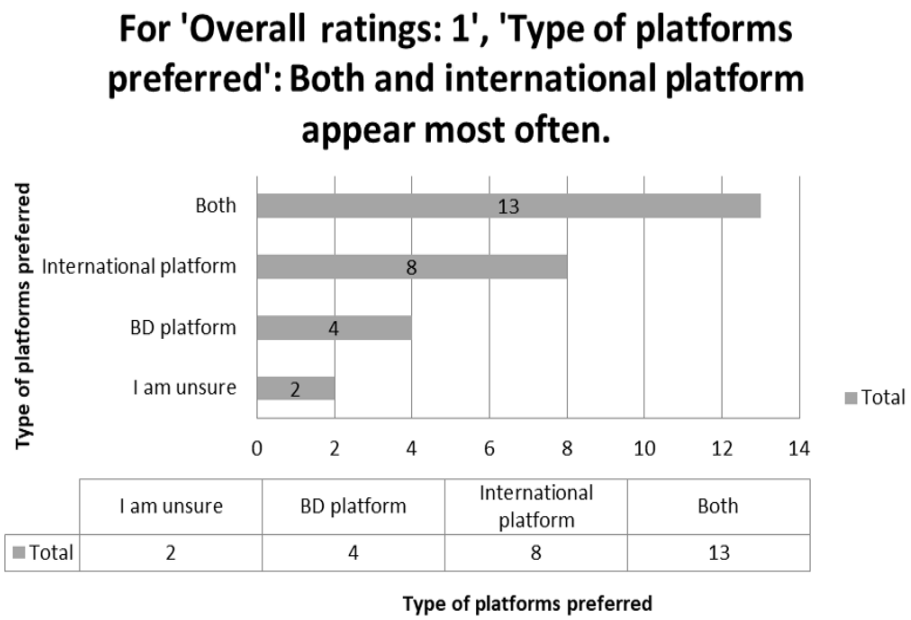

Figure 11. Student preferences in educational platform selection.

4.6. Categorical Dataset

During the epidemic, the adoption of educational technology (EdTech), provided by multiple e-learning platforms, increased significantly. However, students are no longer required to use e-learning resources and platforms, as universities have resumed providing physical learning opportunities. So, based on the survey we conducted, we tried to combine some questions so that we could make an approximate prediction about the future of EdTech in Bangladesh.

Q6: How many courses have you finished from Bangladesh E-learning Platforms during Covid-19? (Open answer)

Q23. When did you become dependent on the e-learning platform? (Before Covid-19, At the time of Covid-19, After Covid-19)

After merging Q6 and Q23 and analyzing them, we get the following line chart, which proves hypothesis 6.

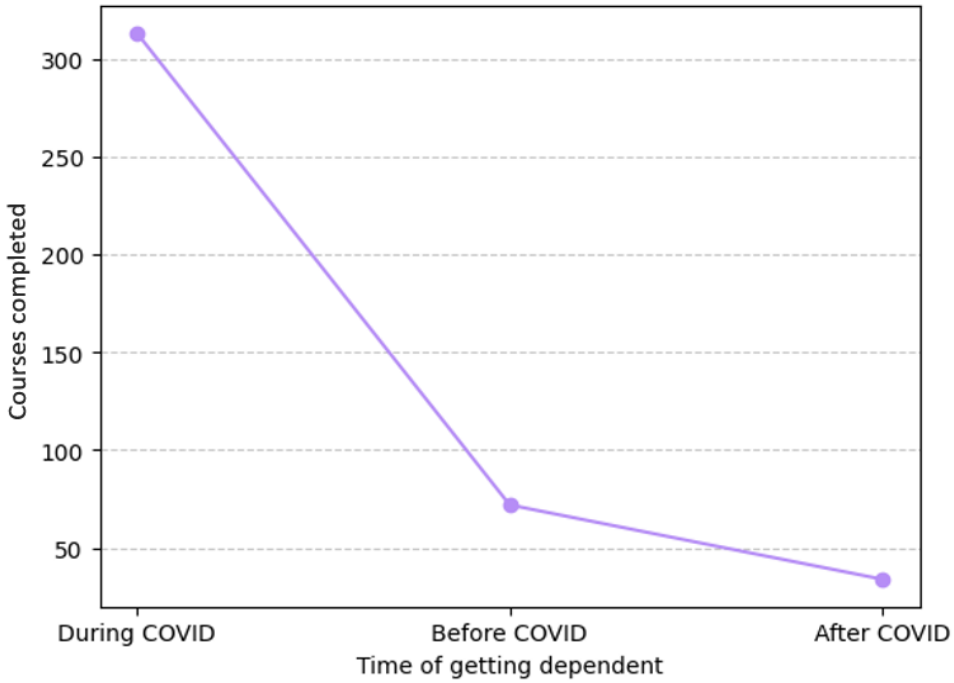

Figure 12. Comparisons of courses completed by time of getting dependent on eLearning platforms.

Figure 12 shows that learners who became dependent on eLearning platforms during COVID-19 have completed most of the courses, proving Hypothesis 6. However, the number dropped for those who began using multiple eLearning platforms after the pandemic. People aren't finding these platforms compelling enough to finish their enrolled courses. The availability of both Bangladeshi and international EdTech platforms is making the learning procedure more engaging and smoother. Additionally, this study revealed that respondents who encountered network issues or other difficulties expressed a need for technical support to resolve these issues, a finding that has a negative impact on Bangladesh's EdTech sector.

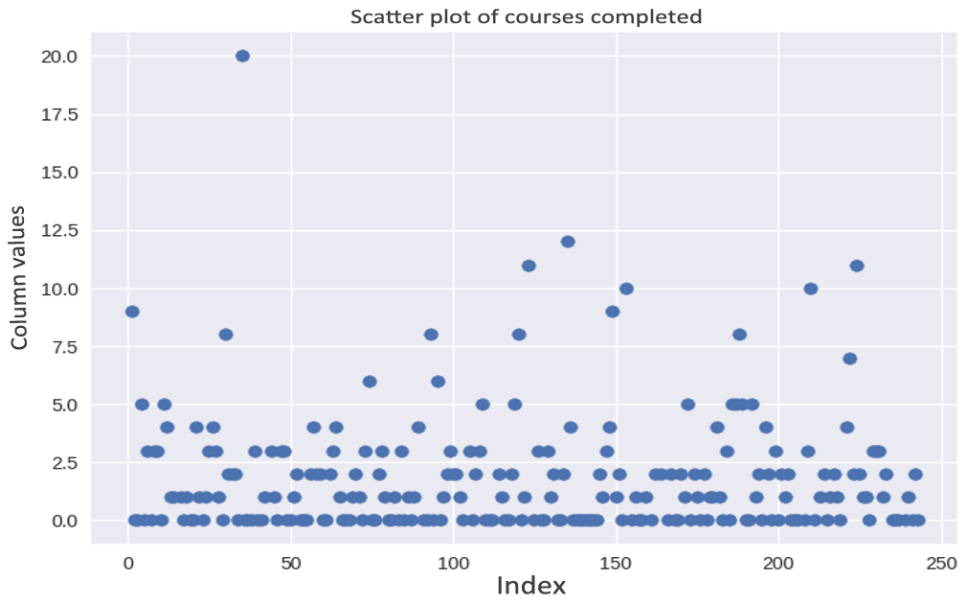

Figure 13. Range of learners of completing courses from BD eLearning platforms.

The scatter plot in Figure 13 further shows that many students enrolled in different courses on Bangladesh e-learning sites have not finished any of the courses. However, many learners have completed at least 1 to 5 courses.

The study revealed students' preferences for e-learning platforms: it provides a better environment than traditional learning, facilitates access to learning materials, and the availability of both Bangladeshi and international EdTech platforms makes the learning procedure more engaging and smoother. Additionally, the study revealed that respondents who encountered network issues or other difficulties expressed a need for technical support to address these issues.

5. CONCLUSIONS

This study aimed to analyze the growth of educational technology and how COVID-19 accelerated the adoption of digital learning tools in Bangladesh. We assumed six hypotheses for this study. Based on the comparative analysis, we found that online learning has much more potential than face-to-face learning. The key contribution of this study is to highlight the significant impact technology has had on Bangladesh's education system, particularly during COVID-19, when the adoption of digital learning tools increased significantly. It provides insight into the current state of education technology in Bangladesh and how students are utilizing these tools. From the above analysis, Higher Secondary Certificate (HSC) and admission candidates are identified as the primary target audience for our edtech platform. A significant proportion of individuals discontinue their undergraduate studies, with the dropout rate often higher than that of graduate students (Gazi et al., 2023).

Educational institutions can use these findings to improve the learning environment for their students. These institutions can better attract students by enhancing facilities, integrating technology in the classroom, and updating content. This way, students will be less inclined to invest their time in coaching centers. Additionally, institutions can explore opportunities to collaborate with various Bangladesh EdTech platforms. This collaboration can create an opportunity for the students to access a vast number of resources and qualified instructors. Many students are unsure if Bangladesh EdTech platforms can help them more than any other international platforms. Language barriers, inadequate awareness, and a lack of training are some of the reasons for their uncertainty. To overcome this problem, Bangladesh EdTech platforms can invest more in creating quality educational content or translating foreign content into Bengali.

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APPENDIX

The questionnaire of this paper is described below. Appendix presents the detailed questions and structure used for data collection.

1) Name (According to Ceritificate)

2)Current Study Status (College Student, Admission Candidate,Undergraduate,Graduate)

3) Department Name/Group (Open Answer)

4) Institution Name (Open Answer)

5)Usage of technology can bring revolution in education sector and can expertise one to compete globally. Which option describes you best? (Strongly disagree , Somewhat disagree , Neutral , Somewhat agree, Strongly agree)

6)How many courses you have completely finished from BD E-learning Platforms during Covid-19?(Open answer)

7)Do you prefer paid or free courses? If you prefer paid courses ,what is the highest amount of paid courses that purchased from an e-learning platform?(Open answer)

8)Digital learning is better than traditional learning. Which option describes your opinion best?
(Strongly disagree ,Somewhat disagree ,Neutral ,Somewhat agree,Strongly agree)

9)"Digital learning makes the learning environment better than the traditional learning environment. " Which option describes you best? (Strongly disagree ,Somewhat disagree ,Neutral ,Somewhat agree,Strongly agree)

10)What type of courses you prefer most in e-learning platforms? (Academic ,Skill Development, Higher Study Related Course ,I am Unsure)

11)How many hours in a day you use your devices for study purpose? (Open Answer)

12)Would you prefer continue using digital learning platforms even after the pandemic has ended?(Yes,No,Unsure)

13)Give a rating to the overall e-learning system of BD. (1,2,3,4,5)

14)Availability of e-learning materials (course, pdf etc.) has increased since the time of the COVID-19 pandemic. What is your opinion in that case? (Strongly disagree ,Somewhat disagree ,Neutral ,Somewhat agree,Strongly agree)

15)Have you ever experienced any technical difficulties using an e-learning platform?
(Internet Connectivity ,High Price of Data ,Shortage of Devices ,Others)

16) Do you believe that EdTech can bridge the education gap for students from disadvantaged backgrounds(e.g. rural areas, bad internet connectivity etc.)? (Yes , No)

17)How did your parents accept this learning process using digital learning platforms during the lockdown?

(Positive ,Negative ,Unsure)

18)Have you noticed any improvements in academic performance after using the digital learning platforms? (Yes,No,Unsure)

19)By completing a course on a digital learning platform, your idea about that topic was cleared perfectly. Which option describes you most? (Strongly disagree ,Somewhat disagree,Neutral,Somewhat agree,Strongly Agree, I am unsure)

20)Digital Learning is a blessing for us.(Strongly disagree ,Somewhat disagree ,Neutral ,Somewhat agree,Strongly agree)

21)E-learning platform will be a multidimensional educative platform and people can smoothly use it without facing difficulties in BD .Which options describes you best?
(Strongly disagree ,Somewhat disagree ,Neutral ,Somewhat agree,Strongly agree)

22)Which of the following type of platform is preferred if you are taking a course on an online platform? (BD platform , International Platform , Both, I am unsure)

23)From when did you get dependent in E-learning platform? (Before Covid-19 ,At the time of Covid-19 , After Covid-19)

24)Which duration(per class) is preferable to you in digital learning? (Less than 1 hours , 1 to 2 hours ,More than 2 hours ,I am unsure)

25).What features do you think are essential in an EdTech tool or platform? (Easy to use, Different learning options, Instant feedback ,Collaboration ,Personalization ,Easy to connect with other tools , Easy to access for all)

26).Do you think EdTech can replace traditional classroom learning? (Yes , No)