

Transforming Higher Education in Bangladesh: A Comprehensive Analysis of the Opportunities, Challenges, and Implications of Online Teaching and Learning

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Abstract: This study focuses on the opportunities and challenges of online learning in Bangladeshi higher education, particularly in achieving Sustainable Development Goal 4, emphasizing inclusive, equitable, and quality education for all. A well-structured questionnaire was administered to collect data from undergraduate students at a public university in Bangladesh. Students' responses were analyzed quantitatively, using descriptive statistics and Chi-Square tests. Quantitative findings on student perceptions reveal significant benefits in terms of flexibility, self-paced learning, cost-effectiveness, and global networking opportunities, improving access and learning experiences among students from remote or marginal areas. On the other hand, the results draw attention to certain significant issues, such as dependence on technology, unsuitable learning environments, social isolation, and receiving feedback very late, which reduce online education success. These challenges underpin the pressing need for considerable investment in the digital infrastructure of affordable access to technology and blended models of learning, integrating online and offline resources that will meet the diverse needs of learners. Improvement in feedback mechanisms, facilitation of online communities of collaboration, and development of digital literacy among both students and educators contribute to better learning outcomes. The research has proposed actionable measures to enhance online education in Bangladesh, such as expanding internet connectivity, providing subsidies for devices, and implementing innovative teaching methods. Addressing these challenges while leveraging the benefits of online learning has the potential to transform higher education in Bangladesh. This will ensure greater accessibility, equity and inclusivity, thereby contributing significantly to the achievement of Sustainable Development Goal 4.

Index Terms: Accessibility, Bangladesh, Blended Learning, Digital Divide, Digital Infrastructure, Emerging Technologies, Higher Education, Online Education, Policy and Practice, SDG 4

1. Introduction

Incorporation of technology in teaching learning has revolutionized education and it is an inevitable aspect of current education systems around the world. Online learning had begun to gain significant momentum in recent years in Bangladesh following the necessity of distance learning during the COVID-19 pandemic. This shift has repositioned the teaching-learning relationship in such a way that it is flexible, accessible, and provides a way to transcend the traditional barriers of geographic and financial limitations [1]. Nevertheless, the potential of online learning cannot be disputed, but the success of online education is conditional upon overcoming issues about technological infrastructure, digital literacy and student engagement [2]. Online learning is one aspect in this striving of Bangladesh to improvement in the sphere of education, which can be directed to reach Goal 4 of the Sustainable Development Goals that aims at inclusive, equitable and quality education to all [3].

Online learning is paramount to the learning and sustenance of an effective online learning environment. Online learning has been outlined as a technology that would potentially help to improve the teaching and learning process since it provides it with greater student-centredness and innovation and flexibility. The most compelling benefit of e-learning is, perhaps, that it can be used to bring education closer to a greater number of students in remote and underprivileged locations. Web-based learning has a flexible solution in a country such as Bangladesh, where socio-economic status and geographic location pose a permanent negative impact on traditional education. Autonomy in learning, low costs and access to international resources are some of the characteristics that make online degrees to be very attractive to students who are constrained by financial and logistical hurdles [4]. These benefits are aligned with the vision of SDG 4 in providing students, regardless of geographical location and economic condition, with access to quality education. Despite these advantages, how fully online teaching learning achieves its promise varies dramatically, with variation depending on whether individuals are connected to the internet, have access to a device and have institutional support [5].

While online learning has several benefits, there are some issues it encounters that affect its efficacy. Lack of access to gadgets, online resources, internet connections, network infrastructures, electricity, learning environments, materials and training pose a major challenge to remote teaching and learning. Most students in Bangladesh are faced with issues of low internet speeds, poor devices and poor digital infrastructure [6]. In the rural areas of the country, there is further complication of such issues due to budgetary constraints and little awareness of digital platforms. In addition, online learning systems lack the social and interactive environment of the physical classes leading to isolation and disconnection among the learners [4]. The teachers are also facing significant problems, including the demands to acquire training online and transform traditional teaching methods into online-based ones. These problems explain the need to have intelligent solutions that address both technological and pedagogical failures of the system.

The current research investigates the opportunities and challenges of online learning in the higher education in Bangladesh and its connection with SDG 4. This research paper makes some conclusions on the role that online education can play in enhancing access, inclusiveness, and quality. The results are expected to guide policymakers, educators and institutions about how to address the current challenges, including expanding digital infrastructure, making devices more accessible and encouraging interactive and engaging learning processes [3]. Finally, the study helps achieve the greater objective of revolutionizing the education sector in Bangladesh by implementing an efficient online learning platform so that the country can move toward equitable and quality education.

1.1 Research Questions

The following research questions were formulated to explore the various aspects of online learning in Bangladeshi higher education, with a particular focus on its opportunities, challenges, and alignment with SDG 4:

- i. What are the perceived benefits of online learning to students and lecturers in Bangladeshi universities?
- ii. To what extent do students and educators in Bangladesh face significant challenges in adopting and implementing online learning, and what are the key barriers impacting its effectiveness?
- iii. In what ways do access to technology, internet connection, and location affect students' online learning experience in Bangladesh?
- iv. How does online learning in Bangladesh contribute towards the achievement of SDG 4 (inclusive quality education for all) concerning accessibility and inclusion?

2. Literature Review

2.1 Digital Transformation and the Evolution of Online Learning in Higher Education

Technological revolution and pedagogical changes have influenced the rise in university level online learning, which has indeed caused a shift in the learning environment over time. Each of these can be viewed through a series of recognizable stages, each earmarked by the introduction of new ideas and shifting theory. With the emergence of social media, online learning platforms and mobile technologies in the 21st century, instructional design evolved significantly.

Online learning and MOOCs have revolutionized education by offering new opportunities for students, teachers and institutions [7]. The COVID-19 epidemic has also shifted higher education axially towards online learning and thus propelled the ongoing current digital transformation. Nguyen-Anh et al. [1] found that students' preferences were shaped by their technological skill, while educators and administrators were more concerned with functionality and feasibility. Some conceptual frameworks, such as the Digital Pedagogy for Sustainable Educational Transformation, describe how to combine digital skills and evidence-based practices with human-AI collaboration in the classroom.

Mhlanga [8] critically discusses how the 4IR can further disempower education by changing the dynamics of face-to-face learning to unstructured internet learning. In the process of this transformation some challenges arise particularly in the Third World nations, as the key elements that make up growth are lacking. The stake holders in higher education such as the members of the faculty, administrators, employers, policy makers and technology providers should ensure that higher education remains responsive to the needs of students and the society as more education takes the online models of learning. In the growing usage of technology in the learning process, it is now of utmost importance that the faculty, the university administrators, policy makers, and technology vendors come up with maintenance strategies that will see online education remain important to the students and employers. This will assist in the development of digital space that assists in learning cooperation and flexibility. Furthermore, this would guarantee a learning environment that would foster teamwork and adaptability.

2.2 Challenges and Barriers in Sustaining Online Education Infrastructure

There are several problems with the long-term viability of online education systems that could make it less useful and less profitable in the long run. These issues arise due to a combination of technological, pedagogical and institutional issues and each of them requires detailed analysis as well as suitable solutions. One of the main concerns is that the cost of building and developing the support structures of digital infrastructure while increasing their demand can become a significant burden to educational institutions. As first proposed by institutions within the past few years, previous systems often become outdated; this tends to occur when the use of new technologies in integration with existing systems devalues the degree of efficiency and quality within an online learning environment [6]. In addition, many instructors are still uncovered and are not capable of effectively transitioning to online instruction and may therefore deliver low quality learning to students [9]. Lack of support from institutions for students and faculty can increase the degree of isolation and limit the creation of the positive educational climate [5]. The lack of robust, ongoing support mechanisms and training programs for teachers, as well as students, needs to be resolved urgently if the digital transformation of education is to be truly successful. In addition, a better conceptual framework for the sustainable application of technology in education is essential to help institutions make informed, strategic decisions that enhance the quality of online learning in the future [10].

2.3 Advantages and Opportunities of Digital Learning Platforms for Inclusive Education

The modern platforms of digital learning are valuable and provide many opportunities to increase openness in the educational process, making it equally accessible to everyone and providing a high individualization of the educational curriculum and fair practices. These systems are specifically designed to meet the needs of a wide range of learners. This means that all students, even those with disabilities, can fully participate in the learning process. Platforms created by Perez-Enriquez et al. [4] integrate features like live transcription, sign language interpretation, and configurable interfaces, enhancing accessibility for students with impairments. The use of open educational resources (OER) enhances unique learning requirements, as noted by Ramírez-Montoya et al. [11], who underscore the significance of developing inclusive material adaptable to various learners. Digital platforms enhance the personalization of education, allowing educators to create tailored learning pathways that address the distinct requirements and preferences of each student [3]. Furthermore, technology has significantly broadened chances for online and distance learning, which was essential during the COVID-19 pandemic, facilitating ongoing educational access for many learners [12]. While these advantages are undeniable, the persistent digital divide and inadequate resources in certain regions remain significant barriers to fully realizing the potential of digital learning platforms. Confronting these obstacles is crucial for fully realizing the potential of digital learning platforms in fostering a genuinely inclusive educational environment.

2.4 Aligning Online Education with SDG 4: Ensuring Inclusive and Equitable Quality Education

Aligning online education with Sustainable Development Goal 4 (SDG 4) necessitates undertaking important concerns such as digital inclusion and equal access to education. The COVID-19 pandemic switched classroom education to online formats and exposed differences in access to educational resources and their quality. This proved that it required prompt intervention again to ensure equal opportunities for all students. For the digital divide to be closed, it has to be ensured that all populaces are given handy access to those instruments [13]. Marginalized populations, such as people with impairments and those from low socio-economic backgrounds, have been disproportionately impacted by the transition to online education, requiring focused interventions to mitigate these issues. The incorporation of artificial intelligence (AI) in education promises to improve accessibility and personalize learning experiences. However, it also raises concerns regarding academic integrity and ethical usage, highlighting the necessity for comprehensive policies that foster inclusivity while addressing potential risks [14]. The resource imbalance between elite institutions and public schools exacerbates educational inequities, as educators in elite

institutions generally have superior resources and training compared to their public school counterparts, hence extending the educational gap [15]. Educational technology could democratize access to quality education by offering novel tools that enhance teaching-learning experiences, especially for marginalized people [16]. Online education can diminish geographical boundaries and enhance social inclusion, as evidenced by schools such as the International University of La Rioja, which caters to a diverse worldwide student population [17]. However, despite its capacity to promote equality, online education may intensify existing disparities if not meticulously conceived and executed. This highlights the necessity of establishing democratic systems that consider varied educational requirements and situations [18].

3. Methodology

This study employed a quantitative research design (See Fig. 1), to examine the opportunities and challenges of online learning among students in Bangladeshi higher education, with a particular focus on its alignment with SDG 4. The study is based on the experiences of 170 students enrolled in bachelor's programs in a public university in Bangladesh who were actively engaged in online learning platforms such as Zoom, Google Meet, Moodle and other similar tools. The research aimed to ascertain students' opinions regarding the benefits, challenges and prospects of online learning. While the single public university focus of the study limits its generalizability to other universities, regions or countries with different educational contexts, it provides valuable information about the special challenges and opportunities confronting students in this setting. Employing its quantitative method, the research attempted to achieve quantifiable data since an effort to comprehend the common trends, patterns and connections within students' online learning experience was sought. The use of descriptive statistics and inferential tests allowed the study to examine and report the data objectively and therefore was suitable for generalization to the intended population of students.



Fig. 1. Research Design and Methods

3.1 Data Collection Tools and Procedure

The tool for data collection was a structured questionnaire, which was designed to capture students' perceptions of online learning, focusing on the opportunities, challenges, and the future of online education in Bangladesh. The questionnaire also captured the availability of online materials and resources and students' views to ensure quality education in the digital learning environment.

The survey was online, using Google Forms for efficiency in data collection. The questionnaire was forwarded to the targeted students through email and Facebook, reaching the students across two targeted departments. The total number of student responses received toward the end of the survey period was 194. After editing, 170 valid responses

were selected for inclusion in the final analysis. Despite the fact that lower response rate is typical of online surveys, the high percentage of valid responses offers assurance to the representativeness of the results. Although this study took around 10-15 minutes to complete the questionnaire, the response rate was quite low in this study as it is quite common when using internet based questionnaires.

3.2 Sampling Technique

The research employed a purposive sampling method in its study to identify those students who were actively engaged in online learning. Participants are selected in a systematic or explicit manner depending on the research objectives due to certain characteristics or criteria [19]. This approach was applied in order to include those participants who had a first-hand experience of online learning and offer considerable consideration of its advantageous as well as disadvantageous connotations. However, it should be taken into account that selective nature of purposive sampling can introduce bias, as it does not represent the entire student population but can possibly falsify the results.

3.3 Data Analysis Technique

Quantitative methods were used to analyze the collected data, with descriptive and inferential statistics having the major focus. Once this was transferred to Microsoft Excel, data cleaning of the data was done to eliminate any discrepancies or unanswered questions. The 170 valid responses were subsequently subjected to the Chi-Square test to examine the correlation of various variables, including the perceptions of online learning among students and their demographics.

To conduct a more comprehensive data analysis and visualization, data cleaning and statistical analysis were done with the help of Python and visualization with its assistance, whereas Jupyter Notebook offered the opportunity to perform detailed analysis and create meaningful insights. This method helped the researchers to determine the major trends and patterns regarding the advantages and difficulties of online learning among the student population.

3.4 Ethical Considerations

The study was ethically approved and implemented in compliance with the ethical standards of privacy, confidentiality, and safety of all the study subjects. The respondents were made aware of the study objective and that they were taking part in this study voluntarily. The answers were anonymized, all personal identifiers were eliminated and information was stored securely, inaccessible to the participating parties other than the research team to analyze it. All participants were informed and gave a very detailed explanation of how their data would be used as a reference in their academic research and not to be shared with any third parties.

4. Results

4.1 Descriptive Statistics

The first analysis is the generalization of the raw data in order to identify overarching trends and student attitudes towards online learning. The percentage of "Strongly Agree" and the percentages of "Agree" are achieved to obtain the results of the Combined Agreement that reveals the attitudes of students toward the different dimensions of online learning.

4.1.1 Benefits of Online Learning - Frequency Distribution

Online learning has a variety of advantages, as it is an attractive substitute to the conventional approach to learning. The prominent strengths indicated by students include flexibility and cost-effectiveness, and self-paced learning. These results are in line with [1] who stressed the necessity of being flexible and providing personalized learning to satisfy the needs of digital learners. The distribution of the responses in the perceived benefits of online learning is discussed in the following table 1 that indicates the way students have rated the main dimensions of the effectiveness of online learning.

Table 1. Frequency Distribution of the Benefits of Online Learning

Theme	Criteria	Example	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)	Combined Agreement (%)
Time and location flexibility	Time and location flexibility for learning	Students can access lectures at any time, from anywhere, helping them balance studies with work or personal commitments	32%	43%	18%	5%	3%	75%

Self-paced Learning	Ability to learn at their own pace	Students can pause, rewind, and replay lecture videos to better understand complex topics	46%	35%	12%	4%	2%	81%
Cost-effectiveness	Reduced costs for commuting and printed materials	Students save money on transport and printing costs by accessing digital resources online	49%	30%	11%	8%	2%	79%
Personalized Learning	Adaptability to different learning styles	Online learning platforms often provide tools like quizzes, forums, and interactive content that cater to different learning preferences	19%	23%	26%	22%	11%	42%
Global Networking Opportunities	Interaction with students and instructors worldwide	Online platforms provide opportunities to connect with peers and experts globally, enhancing the learning experience	25%	29%	24%	12%	10%	54%

“Self-paced Learning” (81%) was the most highly valued benefit, followed by “Cost-effectiveness” (79%) and “Time and Location Flexibility” (75%). These findings reflect the priorities of modern learners who value affordability and the ability to learn independently [11]. While “Global Networking Opportunities” (54%) and “Personalized Learning” (42%) were also perceived as benefits, their lower percentages indicate a need for improvements in fostering networking opportunities and offering personalized learning tools, as discussed by Dziatkovskii [3].

4.1.2 Challenges of Online Learning - Frequency Distribution

Despite its advantages, online learning presents notable challenges that hinder its full adoption and effectiveness. Students expressed concerns about technical dependence, engagement, and feelings of isolation. These findings are consistent with Hamadi & El-Den [10], who highlighted the role of infrastructural and pedagogical barriers in shaping the online learning experience.

The following table 2 presents the distribution of responses regarding the challenges students face in online learning, highlighting key areas of difficulty.

Table 2. Frequency Distribution of the Challenges of Online Learning

Theme	Criteria	Example	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)	Combined Agreement (%)
Time Management	More time required compared to on-campus classes	Students may feel overwhelmed due to the need to manage their own time effectively without on-campus structure	16%	24%	22%	28%	9%	40%
Social Isolation	Risk of social isolation due to lack of physical interaction	Online learning may result in students feeling disconnected from peers and instructors	26%	37%	21%	10%	5%	63%
Feedback Issues	Limited and delayed feedback from instructors	Students often face delays in receiving feedback, which impacts their learning progress	18%	26%	31%	19%	6%	44%
Technical Dependence	Dependence on electronic devices and internet connectivity	The reliance on technology and internet connection is a significant challenge for students	75%	17%	6%	2%	0%	92%
Learning Environment	Difficulty in maintaining focus and engagement	Some students may struggle to stay focused and engaged in an online environment without in-person interaction	77%	14%	8%	1%	0%	91%

“Technical Dependence” (92%) and “Learning Environment” (91%) were identified as the most critical challenges, underscoring the reliance on stable digital infrastructure and conducive home study environments. These findings align with Forbes et al. [5], who stressed the importance of addressing technological and environmental barriers to ensure equitable access to online learning. “Social Isolation” (63%) and “Feedback Issues” (44%) highlight the need for more engaging and responsive online education platforms.

4.2 Statistical Analysis and Visualizations

The Chi-Square test was conducted to assess whether observed response frequencies significantly deviated from expected frequencies, assuming a uniform distribution. A p-value of less than 0.05 indicates a statistically significant difference, identifying key benefits and challenges of online learning.

4.2.1 Benefits of Online Learning - Chi-Square Test Results

The Chi-Square test results reveal significant differences in students' perceptions of the benefits of online learning. Flexibility, self-paced learning and cost-effectiveness emerged as the most appreciated features, aligning with insights from Nguyen-Anh et al. [1].

The following table 3 provides detailed insights into the significance of each benefit based on Chi-Square results.

Table 3. Chi-Square Test Results for the Benefits of Online Learning

Theme	Sample Mean (%)	T-statistic (χ^2)	P-value	Result
Flexibility	37.5	103.117647	0.00000000000000000002132716	Reject null hypothesis (Significant difference)
Self-paced Learning	40.5	128.764706	0.00000000000000000000000007154181	Reject null hypothesis (Significant difference)
Cost-effectiveness	39.5	125.764706	0.00000000000000000000000003132723	Reject null hypothesis (Significant difference)
Personalized Learning	21.0	11.588235	0.02069092	Reject null hypothesis (Significant difference)
Global Networking Opportunities	27.0	23.235294	0.0001136314	Reject null hypothesis (Significant difference)

“Self-paced Learning” (40.5%) recorded the highest mean agreement, followed by “Cost-effectiveness” (39.5%) and “Flexibility” (37.5%). These findings reflect the adaptability and affordability of online education models, as discussed by Ramírez-Montoya et al. [11]. While statistically significant, “Personalized Learning” (21.0%) and “Global Networking” (27.0%) were less impactful, mirroring disparities in platform functionality [3].

4.2.2 Challenges of Online Learning - Chi-Square Test Results

The Chi-Square test results reveal statistically significant differences for all identified challenges of online learning, emphasizing their impact on students' experiences. The below table 4 provides a comprehensive breakdown of students' perceptions of these challenges, arranged by sample means and significance levels.

Table 4. Chi-Square Test Results for the Challenges of Online Learning

Theme	Sample Mean (%)	T-statistic (χ^2)	P-value	Result
Time Management	20.0	17.411765	0.001607379	Reject null hypothesis (Significant difference)
Social Isolation	31.5	53.235294	0.00000000007608332	Reject null hypothesis (Significant difference)
Feedback Issues	22.0	30.882353	0.000003235304	Reject null hypothesis (Significant difference)
Technical Dependence	46.0	339.823529	0.00000000000000000000 0000000000000000000000 0000000000000000000000 0000000000000000000000 00000000002760769	Reject null hypothesis (Significant difference)
Learning Environment	45.5	356.764706	0.00000000000000000000 0000000000000000000000 0000000000000000000000 0000000000000000000000 00000000000000607167	Reject null hypothesis (Significant difference)

“Technical Dependence” (46.0%) and “Learning Environment” (45.5%) were the most significant challenges, emphasizing the reliance on stable infrastructure. These findings align with Moro et al. [6], who highlighted infrastructural inadequacy as key barriers. Additionally, “Social Isolation” (31.5%) reflects the need for collaborative environments, consistent with Perez-Enriquez et al. [4].

4.3 Statistical Visualizations

The results of the Chi-Square tests are presented along with the statistical graphs of online learning advantages and disadvantages in this section. Observed frequencies are the responses of the 170 respondents as received, whereas expected frequencies assume equal distribution over three categories: Agreement, Neutral, and Disagreement. The graphs allow observed and expected frequency comparison and reveal large differences.

4.3.1 Benefits of Online Learning

Time and Location Flexibility

This figure illustrates the observed vs expected frequencies for the theme “Time and location flexibility for learning”. The observed data indicates that 127 students agreed, 31 students were neutral, and 12 students disagreed with the statement. The expected frequencies were 68 for agreement, 31 for neutral, and 68 for disagreement.

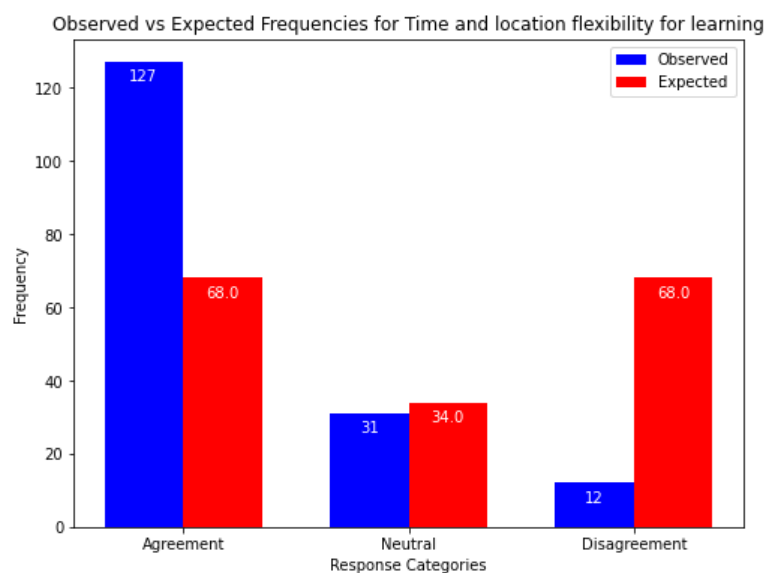


Fig. 2. Usage of Time and Location Flexibility in Online Learning

Fig. 2 validates that students put high value on time flexibility, indicated by the high frequency of agreement scores exceeding the expected scores. The Chi-Square test validates the existence of a statistically significant difference, which indicates that perceived flexibility in online learning is a major benefit. The finding corroborates the conclusion made by Nguyen-Anh et al. [1], in which they noted that online learners enjoy time flexibility in balancing learning activities and personal matters.

Self-paced Learning

This figure illustrates the observed vs expected frequencies for the theme “Ability to learn at their own pace”. Most students (138) agreed, 20 students were neutral, and 12 students disagreed with the statement. The expected frequencies were 68 for agreement, 34 for neutral, and 68 for disagreement.

In this Fig. 3, it indicates that the observed agreement is significantly higher than the expected frequency, emphasizing that students highly appreciate the self-paced nature of online learning. The Chi-Square test supports this difference with a statistically significant result. This finding agrees with Perez-Enriquez et al. [4], who emphasized self-paced learning as one of the main advantages of digital education platforms, particularly for complex subjects.

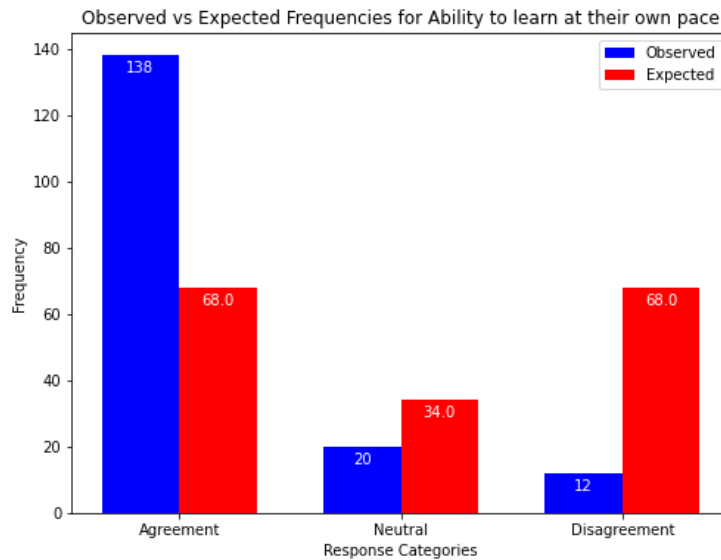


Fig. 3. Usage of Self-paced Learning in Online Learning

Cost-effectiveness

This figure compares the observed vs expected frequencies for the theme "*Reduced costs for commuting and printed materials*". Most students (134) agreed, 19 students were neutral, and 17 students disagreed. The expected frequencies were 68 for agreement, 34 for neutral, and 68 for disagreement.

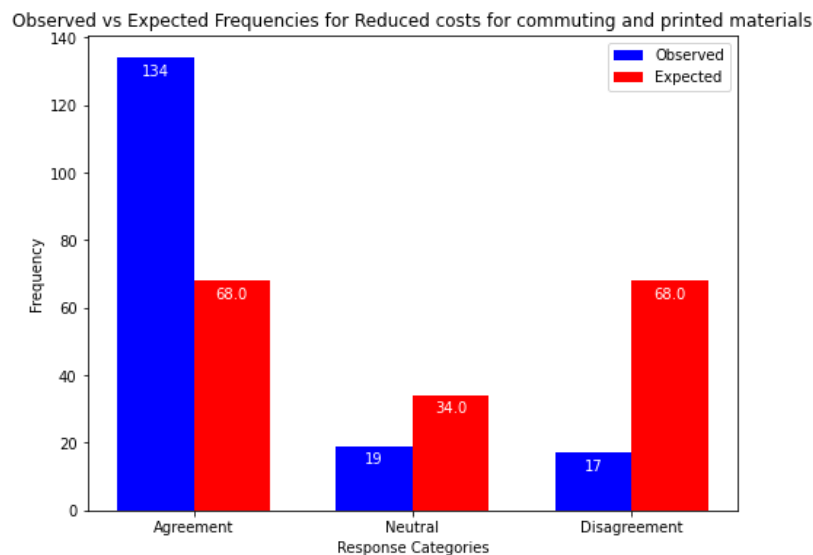


Fig. 4. Usage of Cost-effectiveness in Online Learning

The observed data (Fig. 4) shows a significant deviation from the expected, with more students agreeing that online learning is cost-effective. The Chi-Square test reveals a statistically significant difference, confirming the cost benefits of online learning.

Personalized Learning

Following Fig. 5 illustrates the observed vs expected frequencies for the theme "*Adaptability to different learning styles*". However, 71 students agreed, 44 students were neutral, and 55 students disagreed. The expected frequencies were 68 for agreement, 34 for neutral, and 68 for disagreement.

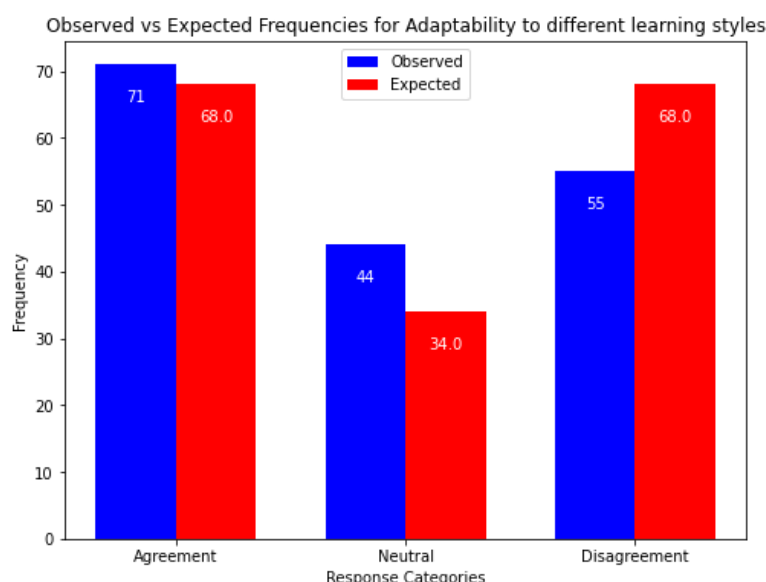


Fig. 5. Usage of Personalized Learning in Online Learning

The observed frequencies show a more moderate perception of personalized learning compared to other benefits. While personalized learning is valued, the responses are more divided, with a significant number of neutral and disagreement responses. The Chi-Square test indicates a statistically significant difference, suggesting that although students recognize the benefit of personalized learning, it is not universally perceived as a major advantage. This aligns with Dziatkovskii [3], who noted variability in how students perceive the adaptability of online platforms.

Global Networking Opportunities

Fig. 6 compares the observed vs expected frequencies for the theme “*Interaction with students and instructors worldwide*”. Most students (91) agreed, 41 students were neutral, and 38 students disagreed. The expected frequencies were 68 for agreement, 34 for neutral, and 68 for disagreement.

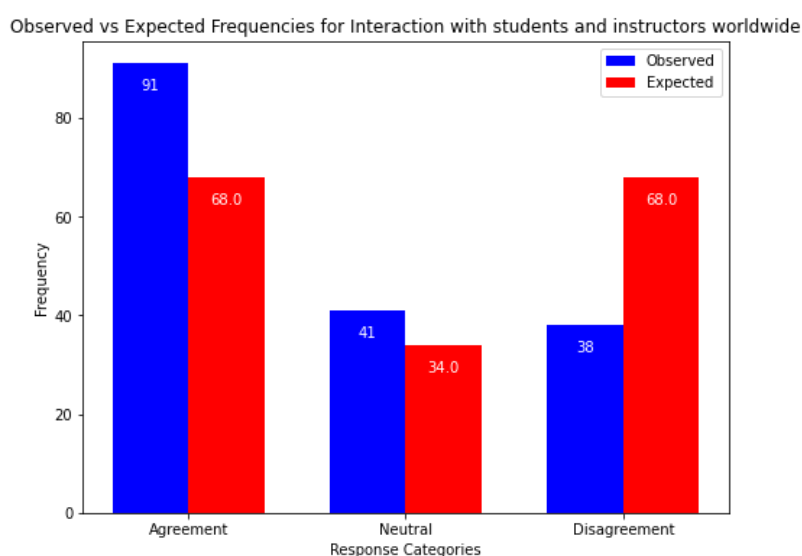


Fig. 6. Usage of Global Networking Opportunities in Online Learning

The data indicate that the majority of students (91) concurred that online learning environments provide excellent opportunities for international networking. The Chi-Square test verifies that the difference between observed and expected frequencies is statistically significant. This corroborates the observations of Perez-Enriquez et al. [4], which emphasized collaborative opportunities in digital education.

4.3.2 Challenges of Online Learning

Time Management

This Fig. 7 compares the observed vs expected frequencies for the challenge *"More time required compared to on-campus classes"*. Most students (68) agreed, 37 students were neutral, and 65 students disagreed. The expected frequencies were 68 for agreement, 34 for neutral, and 68 for disagreement.

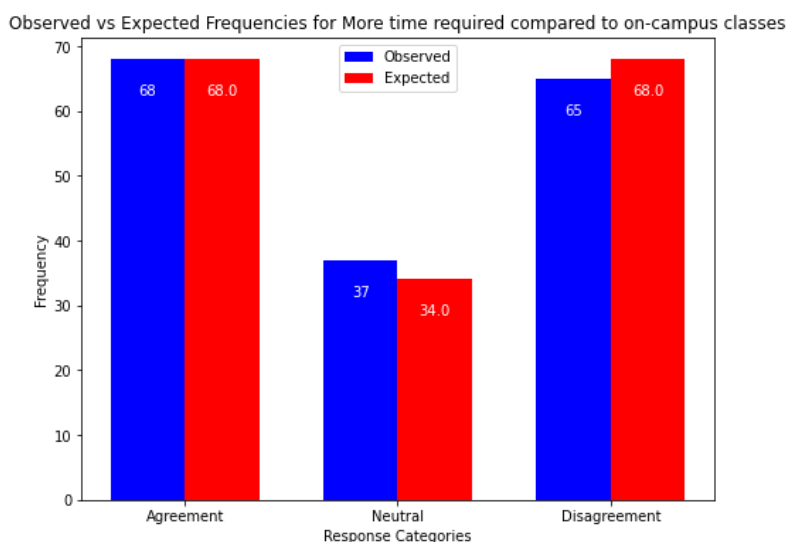


Fig. 7. Usage of Time Management in Online Learning

The observed data gathered indicates that students view time management as a major obstacle, with most of the respondents being uncertain about its effect. The outcome of the Chi-Square test indicates a statistically significant difference, which emphasizes that time management is still a problem in online learning environments.

Social Isolation

This Fig. 8 illustrates the observed vs expected frequencies for the theme *"Risk of social isolation due to lack of physical interaction"*. Majority students (107) agreed, 36 students were neutral, and 27 students disagreed. The expected frequencies were 68 for agreement, 34 for neutral, and 68 for disagreement.

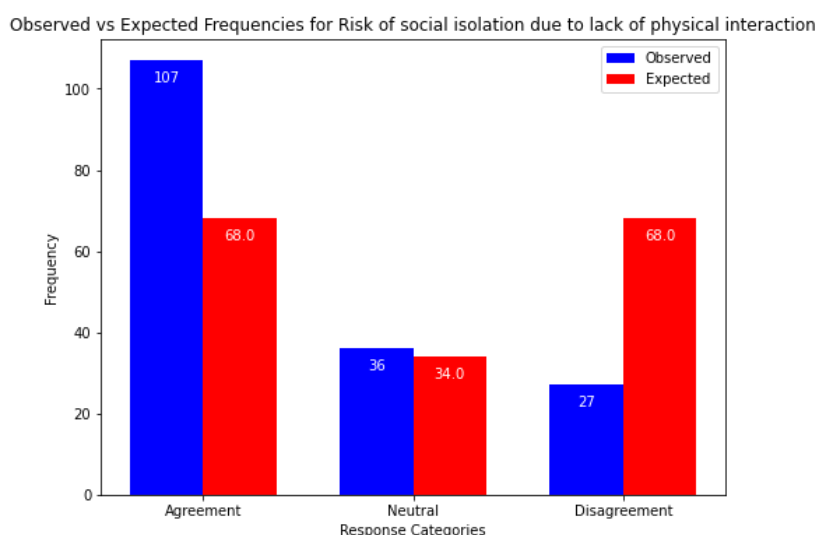


Fig. 8. Usage of Social Isolation in Online Learning

The measured consensus of 107 students is much higher than the expected value implying that social isolation is a serious issue among the online learning students. The Chi-Square test proves that the difference is statistically significant and solutions are required to counteract isolation in online environments.

Feedback Issues

In this Fig. 9 the observed and the expected frequencies of the challenge of limited and delayed feedback of the instructors are shown. The majority of the students (75) agreed, 53 students remained neutral, and 42 students differed. The frequencies were anticipated to be 68 (agreement), 34 (neutral), and 68 (disagreement).

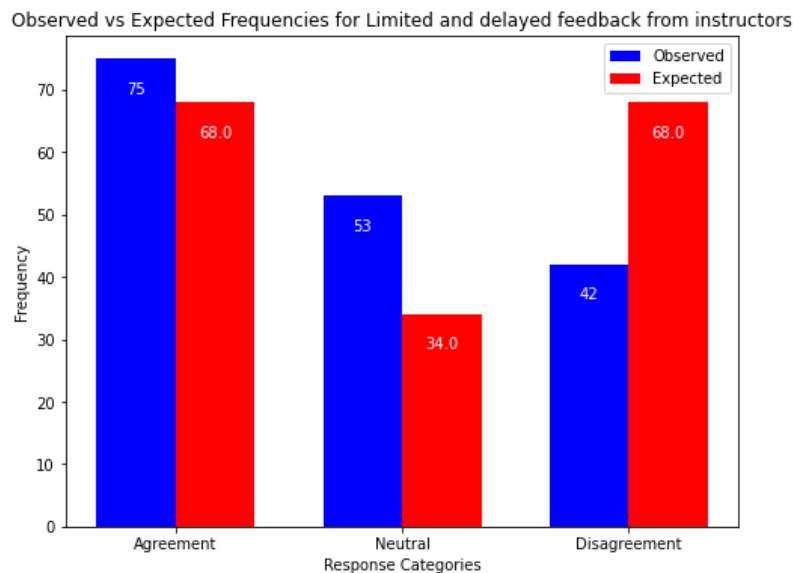


Fig. 9. Usage of Feedback Issues in Online Learning

The observed agreement of 75 students is higher than the expected 68, indicating that delayed feedback is a notable issue for online learners. The Chi-Square test confirms a statistically significant difference, supporting the need for more timely feedback in online education. These results align with Forbes et al. [5], who emphasized the importance of timely feedback in maintaining student engagement.

Technical Dependence

This Fig. 10 compares the observed vs expected frequencies for the theme “*Dependence on electronic devices and internet connectivity*”. Most students (157) agreed, 10 students were neutral, and 3 students disagreed. The expected frequencies were 68 for agreement, 34 for neutral, and 68 for disagreement.

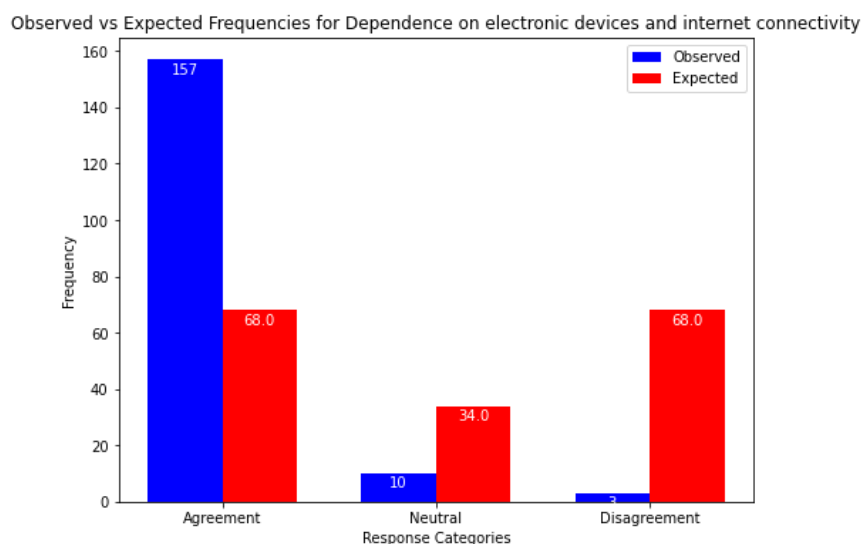


Fig. 10. Usage of Technical Dependence in Online Learning

The frequency of 157 students attesting to the technical dependence issue is much larger than anticipated, demonstrating the high reliance on technology for online learning. The Chi-Square test confirms a very significant difference, with the implication that technical issues are a serious issue for students. These findings are consistent with Moro et al. [6], where digital infrastructure was established as a significant predictor of online learning success.

Learning Environment

This Fig. 11 compares the observed vs expected frequencies for the challenge “*Difficulty in maintaining focus and engagement*”. Most students (155) agreed, 14 students were neutral, and 1 student disagreed. The expected frequencies were 68 for agreement, 34 for neutral, and 68 for disagreement.

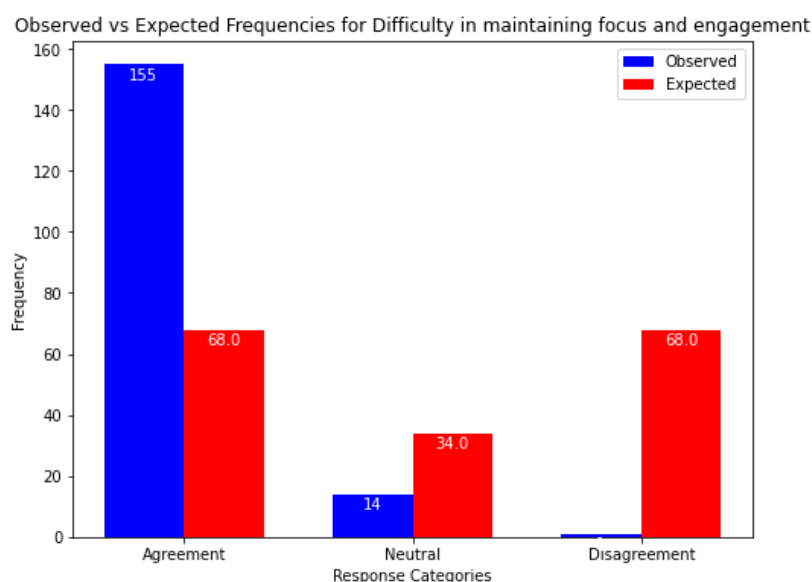


Fig. 11. Usage of Learning Environment in Online Learning

The achieved frequency of consensus among 155 students is significantly higher than the estimated 68 and shows that concentration and attention is a major issue among online learning students. The Chi-Square test proves that there is actually statistically significant difference that requires engagement strategies to take place in online learning.

5. Discussion

These findings can offer a subtle insight into opportunities and challenges of online learning as perceived by students and can inform the way online learning can contribute to Sustainable Development Goal 4 (SDG 4), which focuses on inclusive, equitable, and quality education worldwide. These findings will be incorporated into the discussion together with existing literature and action recommendations offered to optimize online learning.

5.1 Benefits of Online Learning

The findings reveal that the students from the sample participating in this study view online learning very positively. Such a positive view is based on significant advantages like flexibility, self-paced learning, cost-effectiveness, and global networking opportunities. This agrees with Nguyen-Anh et al. [1], and Ramírez-Montoya et al. [11] research, which also identifies the advantages of e-learning tools and how they enhance learning. Flexibility and self-paced learning were the most preferred characteristics, and 81% of the students enjoyed learning at their own pace. This flexibility enables students to balance academics with other responsibilities, such as part-time jobs and family obligations, which is particularly important in developing countries like Bangladesh [4]. Moreover, self-paced learning allows students to revisit course materials and comprehend the most complex topics at their own pace, which improves their comprehension and results.

An equally significant benefit concerned cost-effectiveness, which was defined by 79% of the students, as commuting, accommodation, and course materials were not that costly. These are all very important issues within the Bangladesh context because a person can never afford to undertake any further groups because of the economic barriers. Therefore, online learning presented feasible opportunities to the population groups that are already disadvantaged in terms of access to quality education, which means their inclusion in SDG 4 [11].

Another thing mentioned by the students was the global networking opportunities because half of them saw the value of being connected with their peers, educators, and professionals around the globe. Such engagements contribute to the development of critical thinking, teamwork as well as global awareness to position students to work in an uncertain, competitive world [4]. These advantages allow online learning to have a revolution in education in Bangladesh to ensure that it is available to a wide range of people including those in remote or underserved regions.

5.2 Challenges of Online Learning

Online learning has its evident advantages, but some of the challenges identified in this study must be addressed to utilize it successfully. These include excessive dependence on technology, unfavorable learning conditions, social depression, and delayed feedback. These are as consistent with the findings of Hamadi and El-Den [10], and Richards and Thompson [9].

The worst was the technical dependence; 92% of the students experienced the low-quality of the internet and the absence of personal devices that interfered with the learning. The majority of students with rural or poor backgrounds are experiencing low internet speed and extremely outdated devices that severely limit their engagement in web-based

courses [6]. This problem increases with poor digital infrastructure because massive investment to bridge the digital divide on the provision of educational opportunities is needed to provide fair access to education.

Lack of a favorable learning environment was another major challenge. A total of 91 percent was concerned about distractors at home. The students have either been interrupted by a family member or roommate, or they have no quiet place to study and therefore cannot focus on their studies. The results again underscore that blended learning models, as well as institutional support, must meet a variety of different living situations [5].

Another significant concern was social isolation, as 63% of the students reported a loss of contact with their peers and instructors. A reduction in face-to-face contact leads to reduced levels of cooperation and community building, which is considered an integral part of successful learning by Perez-Enriquez et al. [4]. Further, delayed feedback was also one of the major obstacles, as 44% of the students were not satisfied with either the timing or quality of feedback. This gap gives students a setback in monitoring progress and areas in which they could improve, accentuating the need for interactive, responsive pedagogical approaches that Forbes et al. [5] discuss. Hassan et al. [20] also highlighted the challenges of limited digital infrastructure and teachers' lack of training in using online platforms effectively, which aligns with the difficulties faced by students in this study.

5.3 Implications for SDG 4: Quality Education

This research has important implications to SDG 4 in relation to Bangladesh. The online education has become a tremendous prospect of expanding access to quality education, mostly among the students in remote locations. The advantages of flexibility and affordability, and openness to global networking are directly correlated to SDG 4 objective, which is connected with the provision of inclusive and equal quality education to everyone [8]. According to UNESCO (2020) [21], online education plays the major role of breaking the traditional barriers to education, such as geographical and economical barriers. Through web-based learning, Bangladesh can overcome those disparities, which limit higher education accessibility to disadvantaged groups of people.

Nevertheless, such challenges as technical difficulties, insufficient educational facilities, and social marginalization raised in the course of this research have to be resolved to make sure that online education serves its purpose in meeting SDG 4. According to the United Nations (2015) [22], massive investments in digital infrastructure and equitable access to quality learning resources is essential in the realization of SDG 4 targets at universal level. To make online learning effective and inclusive, Bangladesh should address the challenges listed below by investing in its digital infrastructure and providing the learning institutions with the facilities that would facilitate the use of online platforms by both teachers and students.

Furthermore, according to the report of the UNESCO (2020) [21], an efficient pedagogical framework is the key to the effectiveness of online learning in fulfilling the SDG 4. The report demands that the pedagogical models are adjusted to online learning settings to ensure that learners are more interactive and communicative. There is need to develop interactive, engaging and social learning environments in e-learning to enable the learners interact with their peers and teachers. This will make e-learning sustainable and successful in facilitating positive learning outcomes, which will be directly impactful in goal SDG 4 achievement [22, 23].

6. Recommendations for Policy and Practice

The subsequent recommendations will focus on a strong and balanced online education framework that is sustainable and in accordance with the SDG 4 goals. Online learning can be developed as an efficient instrument of educational equity by overcoming technical, infrastructural, and pedagogical barriers. The following are a few policy suggestions, based on the particular findings of this research, that are applicable to institutions of higher education in Bangladesh to undertake online teaching and learning.

- i. Bangladesh requires a new higher education policy that is bold and specific in its approach to online education with an element of hybrid learning, digital pedagogy, assessment and evaluation, ethical concerns, and funding. A national policy or guidelines should be formulated and enforced by the ministry or UGC so that the HEIs can adhere to it with appropriate customization.
- ii. The UGC needs to collaborate with the government to improve and expand network connectivity in the remote rural regions to offer fair access to digital education. This would solve connectivity problems and provide equal participation.
- iii. Initiate schemes to deliver low-cost or subsidized devices to students, especially the disadvantaged ones. These are the initiatives that can be used to address the technology gap and enhance engagement.
- iv. A centralised national database was needed to facilitate easy access of academic resources by the students. This will equitably give a chance of higher education progression in terms of better learning and research capacity particularly to the people who live in remote locations.
- v. Integrate the online and offline resources in order to suit different learning environments. Online, blended and hybrid learning is capable of overcoming challenges associated with interruptions at home and offering flexibility and structure [23].

- vi. Create virtual classrooms, which have interactive functionalities such as live discussions, group activities, quiz and group projects. This would improve socialization and alleviate the isolation.
- vii. Introduce online technologies that can guide learners in real time and allow interactive learning. These systems have the ability to enhance the knowledge of the students on their progress, and also to keep them motivated.
- viii. Train teachers, students and administrators on how to make good use of online platforms so that they are ready to handle the online learning environment [24]. This will improve the quality of online and blended education.
- ix. Alongside technological improvements, incorporating active learning, peer interactions, and real-time collaboration can enhance engagement and reduce isolation in online environments. Synchronous sessions and collaborative tools can further foster an interactive and inclusive learning experience.

Additionally, there is a necessity to consider the elaboration of explainable AI and forecast models within the online learning system [25]. Johora et al. [25], introduces the necessity of the learning systems being transparent in order to make them respond to the developing needs of learners and provide them with practical recommendations regarding the constant improvement. Although the investigation provides researchers with the useful information about student attitudes, in the future, the longitudinal information can be added to the research to investigate the way or reasons why attitudes stay the same or even change with time, particularly with the constant changes in technology. This type of research would yield a more reliable set of data concerning the ways in which the experience of distance education changes among students, particularly in terms of the digital infrastructure and pedagogical advancements. To resolve these challenges and make online learning successful in Bangladesh as proposed by Tarafdar et al. [26] and Shohel et al. [27], a multi-stakeholder strategy is necessary, which includes policy makers, teachers, and technology developers to establish an inclusive, fair, and sustainable digital learning system.

7. Conclusion

The research investigates opportunities and challenges of online learning at the tertiary level in Bangladesh. Findings revealed that while online learning offers tremendous opportunities in flexibility, cost savings, and global connectivity, it poses overwhelming challenges in dependence on technology, learning space problems, and isolation. The findings respond to the need for targeted interventions to address barriers to the utilization of online education among learners. On the other hand, the advantage of online education, especially its self-paced nature, is well-suited to the reality that it is also best suited to the goals of SDG 4 in terms of ensuring inclusive, equitable, and quality education for all. Yet, to realize its full potential, improvement in digital infrastructure, access to technology, and teacher training are crucial. Addressing the challenges relating to internet connectivity, learning spaces, and interaction between students and instructors, online education can realize its full potential in Bangladesh and become more inclusive and effective for all students, especially in the underrepresented regions of the country. Finally, while online learning has a bright future that could bring transformative change in higher education in Bangladesh, an integrated approach has to be adopted through policy support, technological improvement, and pedagogical innovation. This will, therefore, let Bangladesh ensure that online education will be sustainable and inclusive to ensure that it achieves SDG 4 in ensuring access to quality education for all, equipping students with lifelong learning opportunities across the country.

Declaration of generative AI and AI-assisted technologies: During the preparation of this work, the authors used different AI tools to improve the language and readability. After using these tools/services, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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