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ORIGINAL RESEARCH ARTICLE

Blended learning pedagogy and its implementation in the tertiary education: Bangladesh perspectives

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ABSTRACT

This paper reviews the theoretical foundations and components of blended learning (BL) in higher education globally, analyzing six articles from five countries published between January 2016 and December 2020. The study identified challenges faced by instructors, including workload, timeliness, and lack of academic and technical skills to manage BL. Balancing face-to-face and online learning was also challenging. To address these issues, the importance of staff training, support, and networking was emphasized, proposing a modified BL model for tertiary education in Bangladesh, which could be implemented post-pandemic using a machine-learning approach. The mixed BL model was recommended for Bangladeshi institutions, utilizing machine learning algorithms to facilitate outcome-based learning through technological applications. A preliminary survey of 120 students from BGC Trust University in Bangladesh was conducted using statistical data obtained from machine learning algorithms to explore the applicability of the mixed-learning approach. Machine learning proved beneficial for data analysis, drawing valuable insights for educators and policymakers seeking effective teaching strategies that incorporate technology. This research underscores the potential of machine learning in conducting surveys and analyzing data related to blended learning in tertiary education, offering significant contributions to the field.

Keywords: blended learning; e-learning; tertiary education; online examination; machine learning

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1. Introduction

Blended learning is a kind of binary approach where one is, offline, traditionally face-to-face which is being practiced for age-old, and another is, online, virtually, very recently in special cases and due to obstacles for any situation, in the classroom, the learners and teachers, for education or training based. Another name for blended learning is “hybrid learning” or “mixed learning method”. Blended learning also means practicing ancient technology and modern technology like electronic materials.

According to Bonk and Graham[1] “blended learning systems combine face-to-face instruction with computer-mediated instruction”. Also, Garrison and Kanuka[2] interpret blended learning as “the thoughtful integration of classroom face-to-face learning experiences

with online learning experiences". Though blended learning, a knowledge-based educational approach, is the combination of face-to-face and electronic education systems and is a very popular topic in the field of education today, the implementation of these mixed learning programs in higher education in Bangladesh is very new. This paper aims to explore the concept of blended learning, how to build a blended learning program, the benefits of blended learning, and some requirements for the successful implementation of the blended learning program in the higher education system in Bangladesh. On May 19, 2020, the university grants commission (UGC) of Bangladesh proposed a draft of "Blended Learning for Bangladesh" that incorporated onsite and online teaching in higher education, and it was also approved by the Ministry of Education. The proposed and up-to-date teaching-learning system for higher education in Bangladesh was effective during the pandemic situation and will be more effective if it is considered as a fixed educational method, because students who are deprived of the opportunity of physical participation may overcome the situation via attending online. This will also have a positive outcome on the learning-teaching process. Students will enjoy teaching as a result of using different types of resources in the classroom. This policy may prevent students from dropping out and develop their skills suitable for a competitive world.

To improve university education in Bangladesh, integrated learning or mixed learning could be introduced which offers many practical advantages to specific knowledge in blended learning (BL) areas. The authors address this mission by integrating two coherent and interdependent research-oriented fields of education: university reform and mixed learning. The university reform is evaluated by the growing demands of knowledge on the economy, which intensifies the need for universities to measure and report on the impact of their teaching and learning outcomes. This creates progressive pressure on universities and education systems as a global "reform imperative", requiring ever-increasing transparency and accountability in comparing and evaluating the performance of teachers and students in state-based economies.

The goal of the blended learning approach is to raise the educational partnership standards of the student and his/her teacher with the latest technological advances. In addition, it provides a much simpler style for teachers to teach and for students to learn the basics they need to learn. However, due to time constraints and computer illiteracy, there are limited opportunities for students to participate in this process. As a result, the student's ability to learn and communicate may be compromised. Therefore, there is a need to identify other factors that lead to addressing the existing problems and concerns, hence it forms the objective of this study.

Various studies have identified the importance of the learning approach as an innovative tool for education aimed at developing the language capabilities and computer literacy of 21st-century learners. However, the featured studies have not yet taken into account certain factors such as location, personal comfort, and time, and therefore, raise the question of whether the combined learning approach is beneficial to the students and teachers at all costs. The purpose of this paper is to be able to easily measure the relationship between different components of blended learning based on data and parameters and to determine how these factors test the effectiveness of the program at the tertiary level. In working on this study, we aimed to:

- To identify the program of blended learning;
- To find out the areas of blended learning;
- To calculate the respondents' opinion on blended learning.

1.1. Null hypothesis

Problems and concerns solved through blended learning do not have a significant impact on instructors' discussion and students' participation, consequently not endangering student learning.

1.2. Research questions

For work purposes, we should know whether learners and instructors are facing any problems with blended learning or not. To implement blended learning at the stage of the remote region we have to move off

major obstructs which can create problems at the time of learning. These types of problems are given below:

a) Do teachers and students have any difficulty using blended learning?

b) What are the problems and concerns of teachers and students regarding blended learning due to the following factors?

- Location;
- Internet connection;
- Time;
- Lessons;
- Conversations;
- Computer illiteracy.

c) How do these issues and concerns affect the following variables?

- Academic performance of students;
- Effect of instructors' discussion.

d) Is there an important relationship between blended learning and practice?

1.3. Key elements of blended learning

When emerging theories of constructivism, cognitivism, and performance support, Carman[3] observed that there are five key elements in the blended learning process[2]:

- Live events are synchronous (online class learning activities that happen at the same time), instructor-led learning events in which all learners participate at the same time, such as in a live "virtual classroom".
- Online content learning experiences that the learners complete individually, at their speed, and on their own time, such as interactive, internet-based, or CD-ROM training.
- Collaboration environments in which learners communicate with others, for example, email and online chat.
- Assessment of a measure of learners' knowledge: pre-assessments to determine prior knowledge, and post-assessments to measure learning transfer.
- Reference materials that enhance learning retention and transfer, including PDA downloads, and PDFs.

2. Literature review of blended learning education

The quantity of empirical studies on blended learning that have been carried out in Bangladesh is insufficient[4]. Bangladesh has been striving to create a streamlined kind of online learning due to the COVID-19 pandemic crisis. Having this kind of experience, however, it is important to update and adopt a new learning process that is concentrated on technology. Therefore, the present research was designed to collect quantitative data to measure the student's perceptions and attitudes toward the mixed learning method in the academy[4].

A search of the literature shows that Al-Amin et al.[5] conducted a study on the preparedness, involvement, and classroom activities of tertiary-level students in Bangladesh. According to their findings, which were based on interviews with 844 students from multiple universities in Bangladesh, online education has several drawbacks. Due to the intermittent participation, a limited range of classroom activities, internet, and utility challenges, they discovered that students in impoverished nations such as Bangladesh have average readiness for online education. In an investigation on the effectiveness of online education during COVID-19 in Sargodha, at one private and one government institution, Hussain et al.[6] found that the majority of respondents felt at ease using online tools because online learning met students' educational needs during the pandemic and helped them become independent learners at home. Additionally, although it has some drawbacks, online education exposes students and teachers to a wider range of knowledge. However, based on the results of their survey, they concluded that online learning is the best alternative to traditional learning during COVID-19 and

even in the future if there is a further pandemic like COVID-19. Tabassum et al.[7] conducted a study during the COVID-19 pandemic in Bangladesh to examine online education from the point of view of teachers. According to the findings of their poll, the vast majority of educators (79.8%) are in favor of maintaining the e-learning system during this epidemic. On the other hand, only a very small percentage of educators (1.4%) believe that this method is not sufficient for students to close the educational gap.

EBSCO Academic Search conducted a comprehensive search for articles published on blended learning at AJET, JSTOR, and ScienceDirect in the databases between January 2016 and December 2020 in higher education institutions. The following keywords were used: "blended learning", "higher education institutions", "challenges" and "barriers". The title and summary are presented, and studies are included if they meet the following criteria: (a) addressing blended learning in higher education institutions, (b) referencing challenges encountered and lessons learned from experiences discussed in the institutional context, and (c) being published in English. Finally, it was decided to include six articles in this review and information from these articles is extracted and coded as themes (**Table 1**).

Table 1. Studies are included in the literature review.

Source	Country	Challenges of blended learning (BL)	Solutions/recommendations
Wahab NA et al.[8]	Malaysia	Institutions: • Adaptation of BL in traditional university culture (theme: culture). Instructors: • Finding the right design: difficult work, lack of directional design framework to use, not enough knowledge (theme: finding the right mix). • Increased workload: BL needs more time to redesign curricula, learn new techniques and skills, and interact with students. (theme: workload). • Lack of technical skills (theme: skills). Students: • Partnership: BL requires high-level student discipline and accountability (theme: sharing). • Lack of technical skills (theme: skills).	Institutions: • Assisting faculty in using the latest technology and teaching methods. (theme: support). Instructors: • Provide orientation and training programs (theme: training). • Provide development programs needed to improve university staff skills (theme: training). Students: • Provide detailed tutorials, support services, and helpdesk (theme: support).
Medina LC[9]	Colombia	Instructors: • Spending time developing professional and curriculum (theme: time). • Introducing students to the new format (theme: workload). Students: • Attitude: being skeptical of a new perspective (theme: attitude). • Sharing: responsibility for time management issues and self-learning (theme: participation). • Lack of technical skills (theme: skills).	Instructors: • Get support from organizations (theme: support). • Provide training and orientation before implementation (theme: training). • Collaboration with other faculty members (theme: networking). • Provide graduate student assistance (theme: support). Students: • Provide technical and learning support (theme: support).
Galvis AH[10]	Colombia	Institutions: • Establish general knowledge, skills, and understanding related to new administrative, teaching, instruction design, etc. (theme: culture). • Ensuring the necessary technology and infrastructure (theme: technology). • Changing the thinking and practices of the teaching staff (theme: culture). Instructors: • Do not like to rethink and re-evaluate their practices to meet the needs of students (theme attitude). • Lack of desire to train or advise (theme: attitude). Technical aspects: • Access, cost, and logistics issues limit access to computers in general online practice (theme: internet access, cost).	Institutions: • Implement full national internet coverage and improve national and international access rates (theme: technology) • Analysis of conditions and contexts of students, faculty, support staff, organizations, and technical facilities and access (theme: analysis). Instructors: • Provided training to change policies and practices (theme: training). Technical aspects: • Establishment of a support network team to provide academic and technical support to students (theme: support).

Table 1. (*Continued*).

Source	Country	Challenges of blended learning (BL)	Solutions/recommendations
Kerzic D et al.[11]	Slovenia	Instructors: • Ensuring that the module is error-free and that the content generated is relevant for a long time (theme: module development). • Increased workload: conducting online forums, tutorials, and supporting students (theme: workload). Students: • Engagement and participation: distance learning requires some self-discipline (theme: participation). Technical aspects: • Internet connection failure, students' inability to see the body language in an online environment (theme: internet access).	Instructors: • Identify problem students and provide additional support to help them (theme: support). • Provide training in the academic and technical aspects of the program (theme: training). • Encourage people to communicate with each other and share ideas (theme: networking).
Stepanova EV[12]	Russia	Institutions: • There is no specific policy on how blended courses run (theme: policy). Instructors: • Defining blended learning: finding the right balance (theme: finding the right mix). • Curriculum reconstruction: curriculum rewriting, curriculum learning objectives, and redevelopment of assignments (theme: curriculum development). • Increased workload: preparation and evaluation of students' online work (theme: workload). • Lack of interaction between teachers.	Institutions: • Consideration of pre-implementation development and implementation planning: reducing stress on faculty members (theme: plan). • Choosing the blended learning model that best suits the organization (theme: blended learning model). Instructors: • Provide training in blended learning theory, pedagogy, and basic blockboard skills (theme: training).
Matheos K and Cleveland-Innes M[13]	Canada	Institutions: • Using the blended learning method in limited faculties and departments at HEI for two decades. (theme: limited use).	Institutions: • Training instructors to teach purely theoretical courses using digital technologies.

3. Methodology

To achieve the goals and objectives of the study, the researchers used a cross-sectional quantitative research design to observe, analyze, and report on a specific phenomenon, particularly the mixed learning method, and the issues involved in the educational approach of this generation. The researchers selected a sample of respondents and surveyed them to collect the data, which measured students' perceptions and attitudes towards the mixed learning method in the academy.

The present study employed the "convenience sampling" technique, which is a non-probability sampling technique where the participants are selected based on their availability and interest[14]. Since the students of BGC trust university Bangladesh have got the scope to attend online classes from the very beginning of the COVID-19 pandemic for the first time, a total of 120 undergraduate students were selected from the various departments of this university. It was not possible to use the "simple random sampling" technique and to reach an adequate number of respondents due to the pandemic. The study was based on the analyses of actual data of 120 students who had primary computer literacy and were familiar with BL for their educational purposes.

The survey was designed with a series of easily and appropriately revised questions according to the goal of the study. The researchers finalized the study with support to developing a questionnaire focused on research objectives that would play their part in collecting relevant and quantitative data from the respondents. The questionnaire was reviewed by three expert academicians. Then, the questionnaire was provided among the respondents via an online platform for data collection. To illustrate the responses, the researchers used ratings along with their detailed counterparts. A questionnaire scale was used to describe students' responses (**Tables 2** and **3**). The collected data from the device is matched and calculated. Therefore, based on the interpretation of the data, the result shows the effectiveness of mixed learning that is suitable for the educational standards of the present time.

Table 2. The oral explanation for assessment.

Degree of responses	The oral explanation for assessment
4	Strongly agree
3	Agree
2	Disagree
1	Strongly disagree

Table 3. Range of values scale (oral description).

Rate	Oral explanation	Range
5	Very skilled	4.1–5.0
4	Suitable for most tasks	3.1–4.0
3	Suitable for basic tasks	2.1–3.0
2	Improvement is needed	1.1–2.0
1	Not enough	0–1.0

In analyzing the data, researchers are in the process of providing descriptive statistics that will help them adhere to the research design used. In providing descriptive statistics, researchers should provide observations, interpretations, and conclusions based on data collected without the use of inferential statistics involved in the statistical treatment of data.

A rating of 5 indicates a very skilled oral explanation, suitable for complex or advanced tasks. A rating of 4 suggests that the oral explanation is suitable for most tasks, but may not be as effective for more challenging or complex topics. A rating of 3 indicates that the oral explanation is suitable for basic tasks, such as providing simple instructions or information.

A rating of 2 suggests that improvement is needed in the quality or effectiveness of the oral explanation and that the speaker may need to work on improving their communication skills to be more effective. Finally, a rating of 1 indicates that the oral explanation was not sufficient for the task at hand and that significant improvements are needed.

Overall, this rating scale provides a useful way to assess the effectiveness of oral explanations and can help to identify areas where speakers may need additional training or support to improve their communication skills.

In our online examination system, on exam day, instructors must log in to the exam platform 30 min before starting the exam (**Figure 1**). A unique student id and a temporary password are provided to each examinee so that instructors can verify the students if any interruption takes place. There will be one super admin and two sub-admins among the instructors so that they can manage the system nicely without any middleman. One will operate the system in the absence of the other. They can share tasks among themselves. The reason behind this step is to keep up even the best discipline during the exam. Students will have to join 15 min before the declaration of the exam starts time by entering the password and student id and submitting admit card.

Admit card proves that a student is allowed to attend an exam considering payment and other academic issues. If a student will able to show his/her id and admit and enter the password, he will be allowed to participate in the exam. Otherwise, the student is not allowed. If allowed, the course teacher will provide him with a set of questions in the online classroom and a sub-admin will share the question on the screen. Overall, the course teacher will provide 5 questions set and distribute that to the examinees. Then students will be instructed to open their cameras at 3600 angles so that fair monitoring induces. A sub-admin will explain the rules of procedure and deliver essential information to the examinees. The exam will be started and in progress.

If any examinee turns off his camera, the system will ask him to open it within 3 min. If he opens his camera or informs the instructors of the issue behind the camera turned off then it is okay, otherwise, he will be kept in the waiting room. If any technical issues take place, they will have to be solved within 5 min. If any examinee wants to ask any question or confirm something, he will simply raise the hand option in reaction and ask the question. If any student is observed following any illegal way, our system will warn him. If he exceeds the warning, the system will remove him from the meeting.

The exam is running without any bucketing. After every hour system will announce the remaining time so that students will be aware of the time. An automatic popup message will be sent to everyone 20 min before the exam is over so that they finish their writing and will get ready to create a pdf. If their answer paper is submitted properly and visible to the course teacher, in that case, the system will send them an email notification individually. Extra 5 min will be given to everyone considering technical issues. Those who will be failed to submit their answer paper within the given time must submit it in extra time. When extra time is over, the system will be automatically closed.

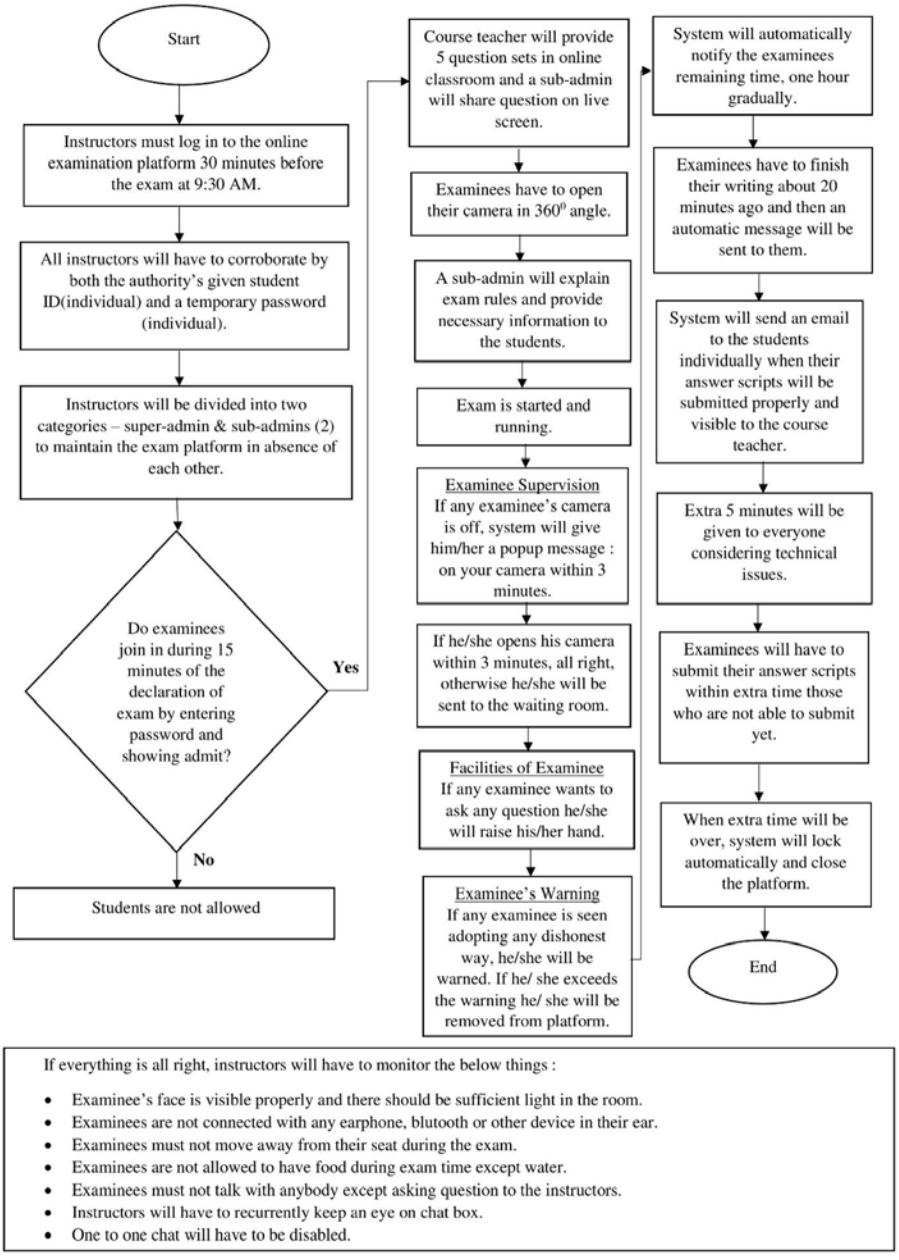

Figure 1. Online examination process using blended learning.

4. Implementation of blended learning

We are proposing the implementation of blended learning for the welfare of university students in Bangladesh. In this approach, students can learn basic things which will be prepended to them as play, so that they do not feel bored at the time of learning (**Figure 2**).

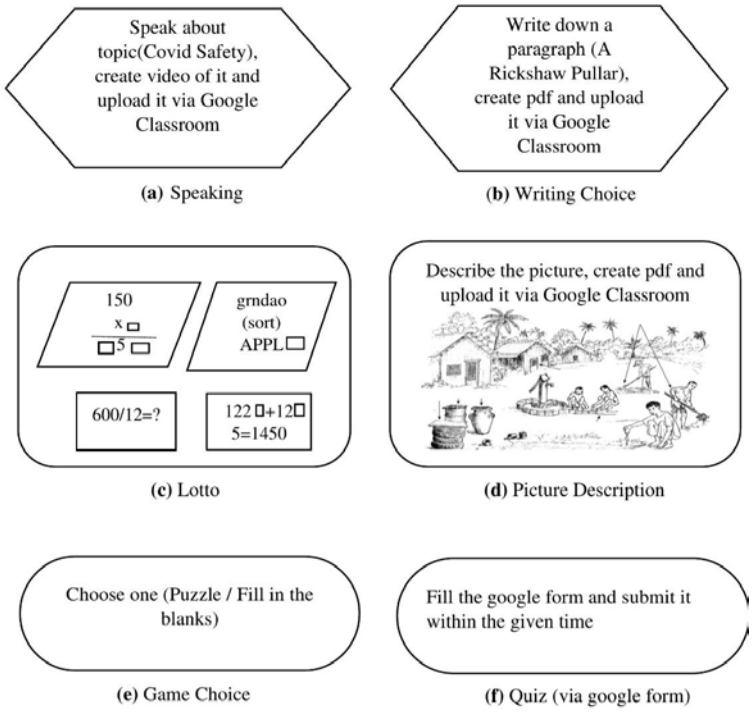

Figure 2. An amusing implementation with blended learning.

4.1. Speaking choice

This is an evaluation in which students can speak unbidden on a given topic. They will be assigned different topics severally. They have to research that topic and speak what they know. At the time of speaking, they will record it into a video and upload the video to the teachers via google classroom.

4.2. Writing choice

This is like writing about a topic. Recent issues can be given to the students so that they can be aware of what is happening in their surroundings. Like speaking tests, teachers will assign different topics severally every day. First of all, students have to study and discuss with each other about the topic then they will write what they have learned with pen and paper. The next step is capturing a picture and creating a pdf with those pictures. After that, they will submit the pdf assignment via google classroom.

4.3. Picture description

Visual learning is the best learning. It is easier for anyone to remember anything or describe it when they have the opportunity to realize it visually. This part of the playlist is about visual learning. Instructors will provide students with some pictures of any topic and students will understand the scenario and write what is remarkable in the picture. They can write uses, abuses, limitations, and facilities of the pictures that they visualize. Their suggestion about the pictures or systems will be accepted with open arms. In this way, they can experience things around them.

4.4. Game choices

Sometimes students can choose one among the puzzles and fill in the blanks in arithmetic operations and the English language so that they don’t feel monotony.

4.5. Quiz

Students will attend the quizzes through Google Forms. In Google Forms, some questions will be assigned to the students based on their lectures. Answers can be short answers, multiple choices, numeration, etc. In this way, learners can be attached to learning continuously. They can develop their skills, and grow their core knowledge. We are optimistic that with this approach we will get very positive output in the field of primary and secondary education.

5. Result

In analyzing the data, researchers are in the process of providing descriptive statistics that will help them adhere to the research design used. In providing detailed statistics, researchers should provide observations, interpretations, and conclusions based on data collected without using inferential statistics involved in the statistical treatment of data. The first item considered in this study is the profile of selected data from the online survey is gender presented in **Table 4**.

Table 4. Distribution of respondents (%) according to gender.

Gender	Frequency	Percentage
Male	68	57
Female	52	43
Total	120	100

Table 4 shows the distribution of respondents according to gender for a particular survey. The table shows that out of 120 total respondents, 68 (57%) were male and 52 (43%) were female.

This type of data can be analyzed using machine learning techniques such as classification algorithms. For example, we might use a binary classification algorithm like logistic regression or support vector machines (SVMs) to predict the gender of a new respondent based on their responses to certain questions in the survey.

Before using these machine learning algorithms, however, we may need to preprocess the data using statistical methods. For example, we might need to encode the gender variable as a numerical variable (e.g., 0 for male and 1 for female) so that it can be used as an input to our machine learning models.

Once we have preprocessed the data, we can split it into training and testing sets and train our machine learning model on the training set. We can then evaluate the performance of our model on the testing set using standard metrics like accuracy, precision, recall, or F1 score.

The second factor considered in this study is to raise awareness of selected data in the study relating to blended learning and its tools provided by the institution (**Table 5**) (office 365).

Table 5. Program awareness (%).

Category	Frequency	Percentage
I know how to manage Office 365 well.	73	60
I don’t know how to manage Office 365 well.	47	40

Table 5 shows awareness of how many respondents are familiar with Office 365. Data shows that 73 respondents (60%) are familiar with Office 365 and 47 (40%) respondents are unfamiliar with Office 365.

On the other hand, **Table 3** shows the effectiveness of integrated learning environments as an experience from research. Oral translations are as follows: 5–4 (very skilled), 4–3 (suitable for many tasks), 3–2 (suitable for basic tasks), 2–1 (improved required), and 1–0 are not enough. The data from **Table 6** includes multiple

categories with different Average Weighted Means and percentages, it would be helpful to calculate the overall Average Weighted Mean and percentage for all categories combined.

Table 6. Areas of blended learning.

SL No	Areas of blended learning	Weighted mean	Standard deviation	Maximum point	Minimum point
Interaction					
1	The interaction I have with my classmates will be increased in blended learning courses.	3.49	0.62	65	2
2	My interaction with the course instructors in blended learning education will be increased.	3.41	0.67	59	0
3	Like in face to face classroom, I am also capable of creating distinct impressions on some of my classmates in the online classroom.	3.19	0.81	58	7
4	I have a sense of belonging in the course.	3.26	0.63	74	3
5	Online communication is an excellent medium for social interaction.	3.33	0.78	56	2
6	I feel comfortable conversing through an online medium.	3.22	0.79	58	6
7	I have the opportunity to participate in blended learning mode outside the school premises.	3.3	0.66	64	2
8	Online and face-to-face interactions are vital for my learning.	3.21	0.81	61	5
9	If blended learning is implemented, online performance and face-to-face class performance will enhance each other.	3.21	0.83	57	7
Average Weighted Mean		**3.29**			
Computer literacy					
1	I know how to manage Office 365 well.	2.65	1.06	44	23
2	My instructors properly teach me how to use Office 365.	2.80	0.93	51	13
3	I have basic knowledge of computer-based discussions.	2.97	0.92	56	12
4	I use Teams (online tasks, assignments, and activities) in blended learning.	3.23	0.74	60	4
5	I use Skype, WhatsApp, Viber, Google Meet, Google Classroom, or Zoom (online platforms) for blended learning.	0.93	0.26	109	0
6	I use Forms (tests and exams) in blended learning.	0.91	0.29	69	0
7	I use Sway and PowerPoint in blended learning.	0.58	0.50	77	0
8	I use Microsoft Word for blended learning.	0.64	0.48	58	14
Average Weighted Mean		**1.84**			
Resources					
1	The instructors maximize the tools that comprise Office 365.	2.81	0.98	53	12
2	I have the resources to participate in a blended learning approach even outside the school premises.	2.99	0.93	55	6
3	Schools provide sufficient resources for this blended learning program.	3.14	0.82	69	0
4	I have a strong internet connection outside the school premises.	0.58	0.50	77	0
5	In my residence, I have a strong internet connection to participate in blended learning education.	0.64	0.48	65	4
Average Weighted Mean		**2.03**			

Table 6. (*Continued*).

SL No	Areas of blended learning	Weighted mean	Standard deviation	Maximum point	Minimum point
Learning					
1	The instructors provide clear instructions on how to participate in the course activities.	3.19	0.79	62	2
2	The instructors focus on discussing relevant issues in a way that helps me learn.	3.33	0.65	63	1
3	The instructors help identify areas of agreement and disagreement on course- topics.	3.23	0.81	65	2
4	The instructors guide the students in understanding course-topics.	3.23	0.78	64	7
5	The instructors keep students engaged in productive discussions.	3.18	0.78	72	5
6	The instructors assign the students tasks in a way that helps them learn.	3.18	0.71	58	5
7	The instructors encourage students to explore new concepts in the assigned courses.	3.23	0.82	65	3
Average Weighted Mean		**3.22**			
Time					
1	The instructors communicate important due dates/time frames for the activities.	3.16	0.83	66	5
2	The instructors provide feedback in a timely fashion.	3.12	0.83	0	0
3	I can manage the time to participate in blended learning outside the school premises.	3.07	0.87	57	9
Average Weighted Mean		**3.11**			
Experience					
1	The workload in my blended learning courses is lighter than that of my normal courses.	2.94	0.93	56	13
2	The workload in my blended learning class is easier to comply with than that of my normal courses.	2.99	0.90	56	11
3	The school makes my experience in blended learning education convenient by providing everything that I need.	3.07	0.82	60	7
Average Weighted Mean		**3.00**			

To do this, we can use the formula:

Overall Average Weighted Mean = (Category 1 Average Weighted Mean × Category 1 Percentage) + (Category 2 Average Weighted Mean × Category 2 Percentage) + ... + (Category n Average Weighted Mean × Category n Percentage)/Total Percentage

For the given data, plugging in the values yields:

Overall Average Weighted Mean = (3.29 × 20%) + (1.84 × 11%) + (2.03 × 12%) + (3.22 × 20%) + (3.11 × 19%) + (3.00 × 18%)/100% = 0.658 + 0.2024 + 0.2436 + 0.644 + 0.5899 + 0.54 = 2.8689

Therefore, the overall Average Weighted Mean for all categories of blended learning is approximately 2.87.

To calculate the overall percentage, we simply add up all the category percentages:

Overall Percentage = 20% + 11% + 12% + 20% + 19% + 18% = 100%

Therefore, the overall percentage for all categories of blended learning is 100%.

The concept of calculating the overall Average Weighted Mean and percentage for multiple categories can be related to machine learning algorithms that involve making predictions or decisions based on multiple features. In supervised learning, the goal is to train a model to accurately predict an output variable based on input features. Each feature may have a different weight or importance in determining the final prediction.

Similarly, in the formula provided for calculating the overall Average Weighted Mean, each category's average is weighted by its percentage to determine its contribution to the overall average. This can be seen as a type of feature engineering where authors assign weights to different features based on their relative importance.

Furthermore, the calculation of the overall percentage involves summing up the individual category percentages. This can be compared to the concept of normalization in machine learning, where the values of each feature are scaled to be within a certain range, such as between 0 and 1.

Overall, the process of calculating the overall Average Weighted Mean and percentage for multiple categories can be seen as a type of feature engineering and normalization, which are important concepts in many machine learning algorithms.

These oral interpretations are considered descriptive tools to measure whether a particular category is sufficient or not. Based on the following tables and as it has been developed and analyzed from the data collected, there has been a balanced functionality when it comes to areas such as communication, sufficient only for basic functions such as chats and emails; computer literacy, which does not allow the majority of respondents because the nominees may or may not have this academic year as their first year of integrated learning; resources are sufficient for the work to be done, especially the tasks assigned to the school premises because respondents will be able to participate in the resources provided but limited to academe; learning that means they are better, learning to be found but is restricted to other aspects and only special; time that is enough to do basic tasks because not many respondents have enough time to travel and participate in integrated learning programs and experience, sufficient for their daily need of entertainment but limited to the physical world (**Table 7** and **Figure 3**).

Table 7. Respondents' opinion calculation (%).

Sample	Areas of blended learning	Average Weighted Mean	Percentage
120	Interaction	3.29	20
	Computer literacy	1.84	11
	Resources	2.03	12
	Learning	3.22	20
	Time	3.11	19
	Experience	3.00	18

In machine learning terms, the given data appears to be a tabular dataset with six features and one target variable. The target variable could be a score or rating representing the overall quality of the blended learning experience in a particular setting.

The six features can be considered independent variables that impact the overall rating of blended learning. These features include interaction, computer literacy, resources, learning, time, and experience. Each feature is assigned a weightage represented by its percentage contribution toward the overall weighted mean score.

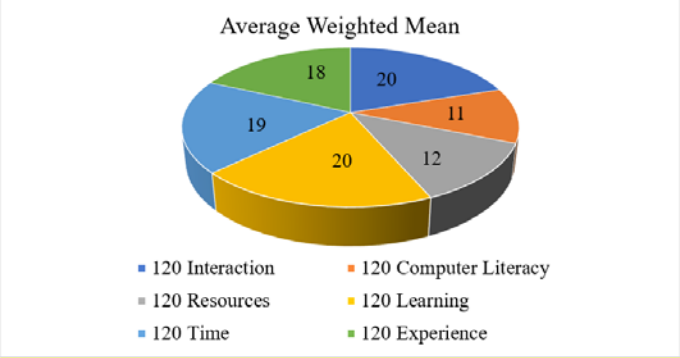

Figure 3. Respondents' opinion in percentage (%).

Thus, an ML model can be trained on this dataset to predict the overall weighted mean score for blended learning experiences based on the values of these six features. The model can use various regression techniques such as linear regression, decision tree regression, or neural network regression to learn the patterns in the data and make accurate predictions.

Furthermore, the trained model can be used to analyze the impact of each independent variable on the overall blended learning experience and identify areas for improvement. For example, if the model predicts a low score for interaction, then it indicates that improving interaction between learners and instructors could enhance the overall blended learning experience.

From **Table 7**, the Average Weighted Mean of the interaction section is 3.29 which indicates that the higher students of our country are capable to do most of the tasks of their daily academic activities using blended learning. From above **Table 7**, we can interpret that the computer literacy of our students is poor because the Average Weighted Mean is 1.84. Through proper guidelines from instructors, it can be recovered. Without proper training, it can be a barrier to implementing blended learning properly. So the improvement of computer literacy is needed based on blended learning. Since the financial condition of the people of our country is not rich enough to buy all the pieces of equipment on time, the students will face some trouble continuing their education online. The main barrier authors say is that the availability of technological resources is limited. Here, the Average Weighted Mean of the resources is 2.03, which is based on the primary data of our online survey.

6. Issues and concerns

It is revealed from the findings of the present study that the computer literacy of participants is poor due to their financial condition, improper equipment facilities, training, and internet facility. These will be the concerns to implement the sound blended learning environment.

7. Recommendations

The government as well as others concerned should come forward to take necessary steps to establish a sound blended learning environment all over the country. Training for improving computer literacy, increasing equipment facilities, and internet facilities may be effective policies for developing blended learning.

8. Discussion

The measured data suggests that current resources are sufficient for basic tasks, and blended learning has become a standardized practice for student education in Bangladesh. The successful adaptation by primary and secondary students to this learning approach, as evidenced by their feedback with a value of 3.22, indicates that they find it both engaging and comfortable.

Furthermore, applying machine learning algorithms to the survey results reveals that blended learning is suitable for most tasks, with a high Average Weighted Mean of 3.11. This demonstrates that students can learn more efficiently through activities such as research, video watching, resource reading, etc. compared to traditional classroom learning systems. In addition, the machine learning model predicts that travel time savings make blended learning more favorable than traditional classrooms.

Regarding the COVID-19 pandemic, the Bangladesh government has taken alternative initiatives to engage students via online activities[15]. However, using machine learning techniques in the recorded classes delivered via television media did not yield fruitful outcomes due to one-way communication. Nonetheless, despite some technical problems, the machine learning algorithm predicts that both rural and urban students in the country have acquired sufficient technological expertise to continue their studies via online platforms such as Zoom, Google Meet, and Google Classroom, with a high rate of 3.00.

Ordinary practice, integrated learning as a new educational tool, and its inclusion in the classroom surpass each other. Mixed learning is a new tool but inclusion in the education system can and may continue to have flawed programs. In addition, integrated learning programs are possible but their success cannot be overstated because:

a) Resources are limited.

Related resources for effective completion and integration into integrated learning are only available within the school premises.

b) Not all students are familiar with technology.

Because all students have had a computer or online classes before this academic year.

c) Learners feel uncomfortable in integrated learning.

Because some are traditional and free to comply with their needs at school.

d) Learners have limited time to participate.

People may have limited time because they are going home or coming home from school, training, and other curriculum activities that can take up a set amount of integrated education.

e) Students have opportunities and ways to participate in this program.

Researchers have acknowledged the fact that not all students have the means to participate in integrated studies such as funding.

f) Fixed duration is a barrier to getting a learning outcome.

At the tertiary level, the course curriculum is planned for throughout the semester/year but instructors have to submit examination questions in the mid of ending courses. If instructors could not keep track of lesson plans in a blended learning system, students would not achieve the outcome of learning the respective courses.

9. Conclusion

In conclusion, machine learning can play a significant role in implementing successful blended learning programs by helping educational institutions to analyze data, identify patterns and insights, and make informed decisions. By following the key points identified through studies, such as conducting needs analysis, selecting appropriate models, providing continuous training, encouraging collaboration among instructors, and creating support systems, institutions can leverage the potential of blended learning to promote effective learning outcomes.

The followings are some key points for successful blended learning implementation summarized from the studies:

- Conduct a proper needs analysis concerning the institution's deliverables and support mechanism before designing a blended course.
- Carefully select a blended learning model that is most suitable for the institution.
- Provide continuous training for faculty staff including instructors and administrative staff on necessary skills needed to conduct the program and to continuously enhance the effectiveness of delivery.
- Encourage instructors to work collaboratively with each other by setting up a networking system for them to share ideas and/or best practices.
- Create a support system for instructors, and students, and also for dealing with technological faults to promote smooth delivery of the program.

Machine learning can help institutions optimize their efforts and improve their results by continuously enhancing their delivery and addressing technological faults. Overall, machine learning has great potential in promoting learning and can be a valuable tool for educational institutions looking to embrace blended learning. The survey results provided valuable insights into the student's awareness, the area of blended learning, and their opinion on where improvements could be made to enhance their learning experience through machine learning. The use of statistical models allowed for a more comprehensive analysis of the data, identifying trends and patterns that would not have been immediately apparent without the aid of machine learning algorithms.

Author contributions

Conceptualization, SM; methodology, SM, MAM, TS, MJA, KK and MHU; software, SM, MAM, AP and MJA; validation, TS, MJA and MHU; formal analysis, SM, MAM, TS and KK; investigation, SM and MAM; resources, MUK; data curation, SM, MAM and AP; writing—original draft preparation, SM, MAM, TS and AP; writing—review and editing, MHU and MUK; visualization, TS, MJA and KK; supervision, MUK; project administration, MUK.

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Conflicts of interests

The authors declare no conflict of interest.

Ethics and consent

Ethical approval for this study was not required in accordance with local legislation and national guidelines. This study does not require any ethical clearance from any party as there was no personal identification information of the respondents recorded during the survey. The collected data were also analyzed in an aggregate manner which further confirms the anonymity of the respondent and their responses.

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