

CAPITAL UNIVERSITY OF SCIENCE AND
TECHNOLOGY, ISLAMABAD



**An Analysis of Students’
Response on Virtual Learning
Environment Adopted due to
COVID-19**

by

Furqan Munir Lodhi

A thesis submitted in partial fulfillment for the
degree of Master of Science

in the

Faculty of Computing

Department of Computer Science

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My dissertation work is devoted to My Family, My Teachers and My Friends. I have a special feeling of gratitude for my beloved family. Special thanks to my supervisor whose uncountable confidence enabled me to reach this milestone.



CERTIFICATE OF APPROVAL

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(**Furqan Munir Lodhi**)

Abstract

Virtual learning environment (VLE) is the internet based education, also called the e-learning or computer based education. VLE has been adopted on the large scale by the educational institutes around the world because of a pandemic situation called COVID-19. For the prevention of this highly infectious disease it was decided to close all the educational institutes and to adopt VLE. This helped in the continuation of academic activity and also saved the precious time of students. However, switching from traditional education to VLE also introduced new set of issues, like lack of infrastructural support, mental readiness and training of faculty members and students, quality of education and others. These issues need to be studied and analyzed in order to make VLE more effective. Such study has not been conducted in the past as moving to VLE at this large scale is a rare situation that never occurred previously in human history. The aims and objectives of this research are to analyze the problems faced by students during online learning, the impact of VLE on the understanding of the students and also the comparison of their academic performance during the traditional education and the VLE. The data has been collected from the ABC University, Islamabad for the survey conduction, feedbacks from students and also for the prediction of the student's results. Then the data has been analyzed using different statistical analysis techniques, WEKA tool, Excel, Python language codes and SPSS software. The results obtained show that VLE has not been much effective for the education during this pandemic and mainly due to lack of infrastructural support to VLE in HEI, Pakistan. The students should be provided with the proper demographic resources for the VLE. The prospective use of VLE by the educational institutes in the post pandemic era needs also to be looked into.

Contents

Author's Declaration	iv
Plagiarism Undertaking	v
Acknowledgement	vi
Abstract	vii
List of Figures	x
List of Tables	xi
Abbreviations	xii
1 Introduction	1
1.1 Problem Statement	4
1.2 Purpose	4
1.3 Scope	5
2 Review of Literature	6
2.1 Traditional Education System (TES)	6
2.2 Virtual Learning Environment (VLE)	7
2.3 COVID-19 and Need of Virtual Learning Environment	8
2.4 Lockdown, COVID-19 and Virtual Learning Environment	10
2.5 Online Learning and Teaching during COVID-19 Pandemic	12
2.6 Prediction of Academic Performance of Students	13
2.7 Students Engagement and their Academic Outcomes	15
2.8 Summary of Review of Literature	17
3 Methodology	20
3.1 Dataset of Student's Feedback and Survey Conducted	22
3.1.1 Pre-processing	23
3.1.2 Data Cleaning	24
3.1.3 Data Analysis	24
3.2 Dataset of Students GPA and Prediction of Students' Final Marks	25

3.2.1	Data Preprocessing	26
3.2.2	Data Cleaning	27
3.2.3	Data Analysis	28
3.2.3.1	Linear Regression Model	28
4	Results	30
4.1	Results of the Feedback	30
4.1.1	BS Subject Discrete Structure Results	31
4.1.1.1	Findings on Individual Subject	32
4.1.2	Average of the Problems Faced by BS Students during VLE	33
4.1.3	MS Subject Web-Knowledge's Results	35
4.1.3.1	Findings on Individual Subject	37
4.1.4	Average of the Problems Faced by MS Students during VLE	38
4.1.5	Correlation of Understanding of Students with Different Factors	40
4.2	Results of Survey	41
4.3	Results of Comparison of GPA of BS Students Spring 2019 & Fall 2019	45
4.3.1	Comparison of GPA of BS Students Fall 2019 and Spring 2020	46
4.3.2	Comparison of GPA of MS Students Spring 2019 & Fall 2019	46
4.3.3	Comparison of GPA of MS Students Fall 2019 and Spring 2020	47
4.4	Results of Prediction of Academic Record of Students	49
4.4.1	Fall 2019 as Training as Well as Test Model	49
4.4.2	Fall 2019 as Training Model and Spring 2020 as Test Data	50
4.4.3	Best 2 Quizzes and Assignments Selected for the Prediction of Results	50
4.4.4	Best 4 Quizzes and Assignments Selected for the Prediction of Results	51
4.4.5	Prediction of Unknown Final Marks (Fall 19 as Training Model and Fall 2020 as Test Model)	52
4.4.6	Prediction of Unknown Final Marks (Spring 2020 as Training Model and fall 2020 as Test Model)	53
4.4.6.1	Final Words	53
5	Conclusion and Future Work	54
5.1	Conclusion	54
5.2	Future Work	55
	Bibliography	56

List of Figures

2.1	Similarities and Differences of Traditional Education System and Virtual Learning Environment [32–34]	8
3.1	Methodology	21
3.2	Questionnaire of the Feedback	22
3.3	Model for VLE System during Covid-19	29
4.1	(a) Percentage of Understanding of Lecture by Students (b) Percentage of Internet Problem faced by Students (c) Students Faced Electricity Problems (d) Students Found the Lecture Topic Difficult (e) Students Faced No Problem During VLE (f) Attendance of Students	31
4.2	Problems Faced by BS Students during VLE	34
4.3	BS Boys and Girls VLE Comparison	35
4.4	(a) Percentage of Understanding of Lecture by Students (b) Percentage of Internet Problem faced by Students (c) Students Faced Electricity Problems (d) Students Found the Lecture Topic Difficult (e) Students Faced No Problem During VLE (f) Attendance of Students	36
4.5	Problems Faced by MS Students during VLE	38
4.6	MS Boys and Girls VLE Comparison	39
4.7	Comparison of GPA of BS Students of Semester Spring 2019 and Fall 2019 Based on TES	45
4.8	Comparison of GPA of BS students of Semester Fall 2019 Based on TES and Spring 2020	46
4.9	Comparison of GPA of MS Students of Semester Spring 2019 and Fall 2019 Based on TES	47
4.10	Comparison of GPA of MS students of Semester Fall 2019 Based on TES and Spring 2020	47
4.11	Fall 2019 as Training as Well as Test Model	49

List of Tables

1.1	Difference between Traditional Education System and Virtual Learning Environment	2
2.1	Summary of Impacts of COVID-19 on Virtual Learning Education.	18
2.2	Summary of Students Performance Using Prediction Models	18
4.1	Correlation of Understanding of Students with Different Factors	40
4.2	Gender of Students Responded to the Survey	41
4.3	Device Used by Students during VLE	41
4.4	Access to the Internet, Quiet Place, Electricity and Digital Tools	42
4.5	Agreeableness of students with the statements asked from them	42
4.6	Comparison of Online and On-Campus Classes, Better than on-campus classes, Same as on campus classes and Almost half compared to on campus classes are represented as Option A, Option B and Option C in table	43
4.7	Comparison of Administrative Staff during Online classes and during TES	44
4.8	Online Classes in Future	45
4.9	GPA Comparison for BS and MS	48
4.10	Values of Root Mean Square of Different Subjects	50
4.10	Values of Root Mean Square of Different Subjects	51
4.11	Root Mean Square Values of Different Subjects.	51
4.11	Root Mean Square Values of Different Subjects.	52

Abbreviations

BS	Bachelor of Science
DT	Decision Tree
KNN	K Nearest Neighbor
MS	Master of Science
NB	Naive Bayes
RB	Rule Based
SARS	Severe Acute Respiratory Syndrome
SARS-CoV-12	strain of coronavirus
SPSS	Statistical Package for Social Sciences
SVM	Support Vector Machine
TES	Traditional Education System
VLE	Virtual learning environment
WEKA	Waikato Environment for Knowledge Analysis

Chapter 1

Introduction

The most fundamental factor in the knowledge and prosperity of students is the effective education. It is very important for students to interact and co-operate with each other and with the instructor concerning the instructed topics [1]. There are two types of education systems i.e., traditional learning system and virtual learning environment. TES is also known as face-to-face and in-class teaching where as the VLE the teacher and the student are not physically present using digital device to conduct class.

Traditional education system is being followed by the majority of the regions of the world and all of the students either school students, college students, undergraduates and graduate students are considering that traditional education system is very productive for the enhancement of social abilities like identity and correspondence of the students. The students studying in traditional education system can gain motivation, interactivity and accessibility. The meaning of interactivity is that the students and teachers can communicate directly and the students are able to clear their confusions regarding any subjects on time and also they can polish their team work skills. In the traditional education system the teachers can directly motivate the students that how deal with the upcoming problems [2, 3]. The classrooms of the traditional education system contain such rooms where rows of chairs and desks are facing the reading desk and also there are clean colored

walls [4]. Traditional education system involves attending the classes on daily basis and the education is mainly focused on the syllabus and teaching system rather than the differences between the learning skills and capabilities of the learner [5].

Virtual learning environment is also called the E-learning education, computer based education or internet based education in which the teacher and the learner are not physically at the same place or the face-to-face [6]. The virtual learning environment represents the electronically supported education, the instructions are offered to the students through internet and/or computers. A lot of electronic methods are used for the interaction with the students and for the delivery of instructions to the students [7]. Virtual learning is also called learner centered learning and in some universities the education is becoming learner centered that's why electronic delivery of lectures has become popular and its helpful to the traditional education [8]. Virtual learning environment provides students with different education related things like quality of education, development of education and organization of education in the virtual environment [9].

Table 1.1. Difference between Traditional Education System and Virtual Learning Environment [10].

TABLE 1.1: Difference between Traditional Education System and Virtual Learning Environment

TRADITIONAL EDUCATION SYSTEM	VIRTUAL LEARNING ENVIRONMENT
Inactive learning based on subject matters narration	Active learning based on subject matters application
Teacher directed education	Learner directed education
Group work	Individual work
Packages of scientific subject matters	Interdisciplinary application
Inactive learning sources	Service supplying to web/internet
Learning how to get ready for exams	Useful for future

COVID-19 stands for Corona Virus Disease 2019 which is caused by the novel coronavirus named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) [11]. In December 2019, the first case of COVID-19 was reported in Wuhan China. The Coronavirus was transferred to the humans through the seafood and also by the other animals like rabbits, bats and pangolins in China [12–14]. The

COVID-19 is also transmitting from human to human because the coronavirus can survive in the air as aerosols and can easily be transmitted from one person to another. That's why within few days it spread from China in all over the world and till now according to the World Health Organization Report the total cases of COVID-19 are 77.4 million, recovered people are 43.7 million and deaths are 1.7 million [15, 16].

Due to COVID-19 pandemic the whole world decided to do lockdown to prevent the disease because it can be prevented by social distancing. Due to COVID-19 pandemic the whole world decided to do lockdown to prevent the disease because it can be prevented by social distancing. So for this purpose, all educational institutes, markets, restaurants, factories and offices were closed. This situation badly affected the economies of the whole world especially of the underdeveloped countries. COVID-19 along with the health concern is also affecting the education system of the world [17, 18]. The first case of COVID-19 in Pakistan was reported on 26th February, 2020 in Karachi by the Ministry of Health Pakistan and after that another case was reported on the same day in Islamabad. After that the COVID-19 spread throughout Pakistan within few days and these all Corona cases had travelled from other countries like UK and Iran and COVID-19 was at the peak in those countries [19–21]. In Pakistan till now there are total confirmed cases 467,222, deaths are 9,753 and recovered people are 418,958 [22].

Like other countries the Government of Pakistan also decided to do a complete lockdown to prevent and control the spread of COVID-19 in the country. So all the educational institutes were closed and the education system was transferred from traditional education system to the virtual learning system in some schools, colleges and universities where the internet facility was available. It was a great challenge for both the teachers and students to adjust in virtual learning environment within few days to save their semesters or years of study [23]. This step was taken for the prevention of the COVID-19 to keep away students from classrooms and provide them VLE [24]. But the online education has badly affected the education system all over the world including Pakistan because it does not have any face to face interaction with the teachers. And also there are some areas

in Pakistan where the internet facility is not available so those students had been facing a lot of problems in attending online classes [25].

ABC university was following the traditional education system but due to COVID-19 it has also converted its traditional education system into the virtual learning environment. ABC university is using the Microsoft Teams for conducting online classes and delivering the lectures to students. The virtual learning environment feels very unique to students and teachers in the start but with the passage of time they become used to virtual learning environment. The students belonging to those areas where there is no internet, faced difficulties in attending the classes and also during examinations.

In this research, the impacts of virtual learning environment on the student's academic session, their response to the online education system, and the problems faced by them in studying during the COVID-19 were analyzed [26].

1.1 Problem Statement

Due to COVID-19, the educational institutes were closed all around the world. TES rapidly changed into the VLE, due to sudden change in the education system the students who were not aware of the online education system faced a lot of problems including electricity, internet and electronic devices etc. The Impact of this change from TES to VLE needs to be studied with respect to demographic and academic perspectives.

1. **RQ1:** What is the impact of VLE on the understandability of students?
2. **RQ2:** What is the comparison of the student's academic performance in traditional education system and virtual learning environment?

1.2 Purpose

The purpose of this research was to analyze the conversion of TES to VLE, the impacts of COVID-19 on the student's curriculum activities and also to compare

their academic records of students in VLE and TES because it is the major concern which is to be studied all around the world that how the COVID-19 pandemic has affected the TES of the world. To suggest improvement for VLE to be ready to face such situation again.

1.3 Scope

The scope of the work presented in this thesis is any higher education institution that face a paradigm shift in teaching approach i.e., from TES to VLE. This study evolution the impact of this paradigm shifts on the academic performance and understandability of student. It will help the teachers and administration to focus on the issue that can raise quality of education in VLE.

Chapter 2

Review of Literature

Education is very compulsory for all of the human kind and its importance cannot be denied. The lives of the people can be changed by the help of education and only the educated people can survive in tough days of life because their personality becomes polished with the help of education [27]. As it is commonly said that a complete person is the one who is educated. So for the purpose of gaining education, in every country there are different education systems used including the traditional education system and virtual learning environment.

2.1 Traditional Education System (TES)

The traditional education system involves the face to face teaching methodology, in this type of education system all the curriculum and syllabus is designed by the teachers for the students and the teachers deliver the lectures to the students and the students completely depend on the teachers for their assignments and exams [28]. The students are directed by the teachers to learn a particular concept. TES is very necessary for the motivation of the students, because the learning at classrooms has its own benefits like proper guidance, extra-curricular activities and social exposure.

The face to face lectures has many benefits like the students can clear their confusions related to the lecture any time when they are at the institute and also the

student's self-confidence increases with face to face education. Students can take part in different activities like games and their learning activities can increase with time. As far as the social exposure of the students is concerned, in the traditional education system the students get exposure with different teachers and students, sharing of knowledge takes place and groups of students make this education system as a relaxing type of education [29]. The traditional classrooms believe on the routine learning, they contain the rows of desks facing the lecture desk of the teacher, colored walls. The education is based on the teaching material and it does not consider the learning skills and capabilities of the learner [5].

2.2 Virtual Learning Environment (VLE)

The use of electronic devices for the delivery of lectures to the students is called virtual learning environment. The interaction and information is transmitted with the help of computers and internet, it does not involve the face to face teaching methodology. The virtual learning environment is also called e-learning or learner based learning [7]. The main aim of the virtual learning environment is to engage the students more during the lectures and also to make students active to learn new concepts [30]. In the e-learning systems, the teachers act as a facilitator for the students and students are facilitated with all the necessary resources for learning to avoid any type of disturbance in learning. In the online learning attention of every student is made sure, and if there is an activity given by the teacher then it can be done with group work or collaboration of all students [28].

In the e-learning systems, the teachers act as a facilitator for the students and students are facilitated with all the necessary resources for learning to avoid any type of disturbance in learning. In the online learning attention of every student is made sure, and if there is an activity given by the teacher then it can be done with group work or collaboration of all students. There is another benefit of the online learning that students do not have to travel large distances and it is easy for them to get online and attend their class [31]. Another aspect of e-learning is that the students can learn from modern experts and can apply this knowledge

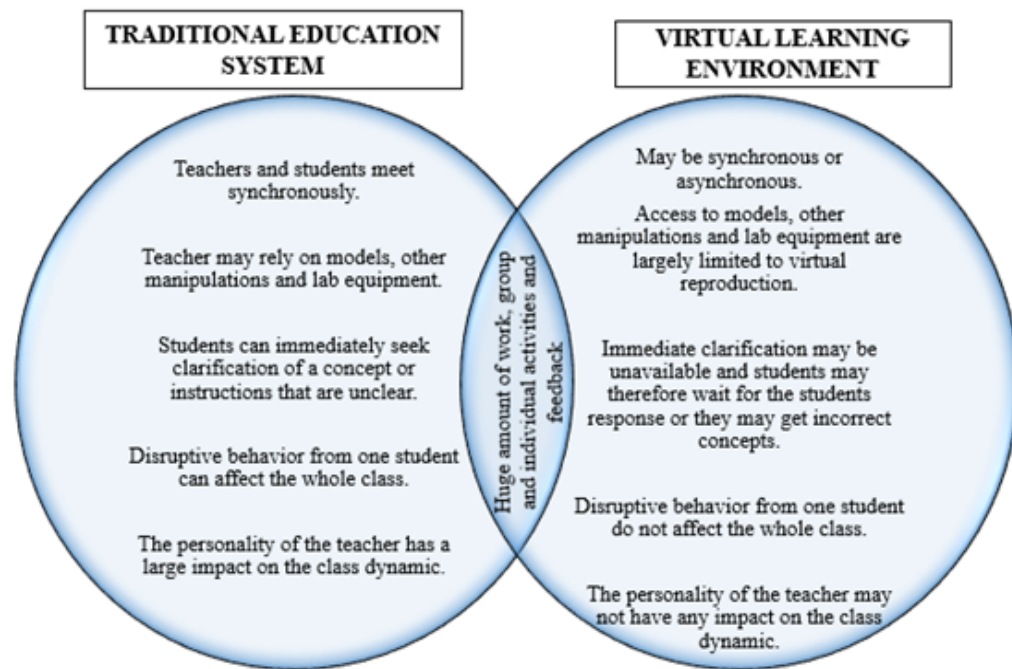


FIGURE 2.1: Similarities and Differences of Traditional Education System and Virtual Learning Environment [32–34]

to the traditional education system also [31]. Researchers said that e-learning is improving the learning and teaching activities of the teachers and students [31].

2.3 COVID-19 and Need of Virtual Learning Environment

COVID-19 is caused by a novel Coronavirus named Severe Acute Respiratory Syndrome Coronavirus 2, that's why it is called SARS-CoV-2 and COVID-19 stands for Coronavirus Disease 2019 [11]. In this world there are many history of deadliest pandemics. Currently, the world is facing a very infectious disease called COVID-19 pandemic. This pandemic has increased mortality and morbidity rate and also causing the political, social, economic and education disturbances [35]. That's why it was declared as a pandemic by World Health Organization (WHO) on January 30, 2020 [36]. The first case of COVID-19 was reported in Wuhan China in December 2019 after that within few months the disease spread throughout the different countries of the world [36].

In Pakistan the two cases of COVID-19 were reported in Karachi and Islamabad in February 2020 by the Health Ministry Karachi and Islamabad [37]. The cases increased day by day in Pakistan, so the Government of Pakistan also decided the lock down throughout the country in March 2020. As a result the educational institutes were also closed to prevent the COVID-19 cases [38]. All the educational institutes were directed by HEC to get prepare for the conversion of the traditional education system to virtual learning environment, and gave clear instructions that till the crisis of COVID-19 remains in the world the virtual learning environment will be there in the educational institutes [38]. This COVID-19 pandemic has very severe effects on the instructors, students and educational institutes throughout the world [39]. So the complete education system was converted into virtual learning environment so that the social distancing can be followed by the students [40].

As it was the first attempt for the students of Pakistan that their education system was converted from traditional education system to the virtual and distance learning environment, that's why it was having a lot of challenges and obstacles to get habitual with this learning environment [41]. These challenges has to be faced by the students because no one knows that when will this pandemic finish from the world, so they used the electronic devices for attending the classes [42]. The COVID-19 has badly affected the traditional education system throughout the world [43]. It compelled the education experts that they feel feasible with the distance learning rather the traditional education system [43]. The online learning has advantages but in those countries which are digitally advanced not in the underdeveloped countries like Pakistan where in most of the areas there is no internet access [44].

In Pakistan, all the academic, institutional and administrative activities are dealing manually [45]. Because there is lack of access to affordable, fast and reliable internet connections so it is very difficult for the students to handle the education through the virtual learning environment [46]. Some students are trying to access the internet by their smartphones, but smartphones are not a reliable source of the online learning because a lot of activities which cannot be done by the help

of smartphones. The sudden change to online learning has become a problem for most of the students of Pakistan [47]. Another major concern associated with the online learning is the lack of the face to face interaction with the teachers. In online system if a student has any query regarding any subject or lecture he/she has to email the teacher and then wait for the response of the teacher for a time [48]. From the digital learning environment the environment of classroom is missing and also these classes are short of sharing of ideas, information and knowledge among students [49]. The social interaction and activities are very important for the learning growth of children which is not present in the virtual learning environment [50].

2.4 Lockdown, COVID-19 and Virtual Learning Environment

A survey was done to check the number of students involved in e-learning, so 232 undergraduate and graduate students completed the survey forms through Google. From the survey it was noticed that 70% of the students are involved in the online learning systems during lockdown. The statistical analysis was performed using Statistical Package for Social Science (SPSS) software. From this study, the researchers suggested that there should be a proper academic plan for the colleges and universities. During this pandemic, there is a need to start a proper education community plan to endure the learning process. It was also noticed that those students who were not having access to internet they denied to study in online programs because of the lack of resources with them so in this way they wasted their semesters. The students who are hard of hearing are also facing problems in online learning systems [51].

A research was done on the response of students for the online learning environment during the pandemic situation [42]. The researchers are also focusing on the online learning system that the online learning is implemented not only in the COVID-19 situation but it could be the innovative and alternative source of learning in the world. It is suggested that from system, material aspect and technical

aspect the online learning environment must be properly prepared. The research was conducted through getting the data by online interviews, questionnaires and observations. The study shows that WhatsApp is the best medium for the online learning during the pandemic conditions due to the reason that it is mostly used as a social media application. Almost all of the people are familiar with the usage of the WhatsApp so it is the easiest source for the online classes for the students and teachers also [52]. A study was made for checking the impacts and strategies of flipped study hall for the online learning. After the end of the course, the basic materials come from the course outline composed by the understudies.

This basic material is important for the investigation and assessment of learning abilities which the students have completed during the online learning. The synopses of 39 students were taken and these showed that the flipped study halls are executable for the purpose of web based instructions. The execution of advanced learning could be done in the in-class exercises, before class exercises and after class exercises. The positive advantages of the flipped classrooms was that the instructor feels relaxed while teaching in the class. From the research it was proposed that colleges should take some steps for the arrangements for the instructor to get adapted to the flipped classrooms [53].

A research was done in Nigeria to check the effects of COVID-19 on the closing of schools on higher foundation. Different information was utilized in the research like the COVID-19 effects on higher foundations, disturbance of scholastic schedule of higher organizations, decrease in the worldwide instruction, global gatherings, learning and education loss, reduction in the financial plan for advanced education and loss of labor. The research recommends that the accompanying measures should be taken by the public authority and the schools should remain closed to avoid the spread of COVID-19 infections. According to the research, the learning of students is highly affected because of closing of education institutes by the COVID-19 pandemic because the external and internal conferences were cancelled and also the examinations were cancelled. So the COVID-19 pandemic has created gap in learning and teaching and also the manpower shortage due to the deaths caused by it [54].

2.5 Online Learning and Teaching during COVID-19 Pandemic

A study was done on the modes of the learning and teaching of the Mizoram University for resulting assessments and education learning measures. The researchers have told all the web-based sources of the lectures delivery like WhatsApp and telegram is 100% used all over the world for the conveying of lectures to the students during the lockdown in the pandemic situations. During the pandemic of COVID-19, to consider the imprints of the understudies and educators on the online learning gets suspended. The analysts collect the itemized data in the semi-organized meetings for the necessities of learning measures for the online education systems. The unstable organization association was the important test. The major problems were faced by the understudies and their problems and issue regarding the online education system were identified and were studied which includes the discontinuous sign issues and continuous power associations. Others problems like the reach for visionary educating, absence of degree for important cooperation, level of understanding and automatic direct of classes were the huge difficulties exposed by instructors. Hardly, there should be different resources for this pandemic to grow an education system which could handle all the problems and issue of the students, instructors and educational institutes [55].

A study was made on the comparison in learning outcomes of the face to face and online teaching methods. The purpose of the study was to check that the students learn more actively in the online learning or in the face to face education. So researchers observed 4 classes taught by the same teacher and all the conditions were same except the teaching method i.e., face to face and online learning. From this research it was concluded that the learning outcomes of the face to face learners was good than that of the online learning. The reasons told by the researchers are that in the face to face learning the students become more active and they focus on the instructions given by the instructors to them and also they look at the behavior of their friends so they get motivated by their attentiveness in the lectures [56].

When the semester starts or any other new session starts there are some difficulties faced by the students to learn the concepts of the course in the beginning. This paper also demonstrated that the courses of college students are related with one another, so it is very useful to predict them. The results of this research were compared with the traditional as well as online learning systems. Most researchers rely on the online learning but the focus was on the face to face learning. The performance of the students was analyzed in the initial stages of the courses. The performance of the students can also be affected by many other factors like the psychological status, health and family of the students [57].

2.6 Prediction of Academic Performance of Students

A considerable attention has been achieved by the educational mining. A lot of data mining techniques are planned to obtain the unknown knowledge from the educational data. There is an improvement in learning process and teaching methods by the help of extracted knowledge. A considerable attention has been achieved by the educational mining. A lot of data mining techniques are planned to obtain the unknown knowledge from the educational data.

There is an improvement in learning process and teaching methods by the help of extracted knowledge. The overall education outputs and the performance of the students can be improved by the improvement in the educational institutes. In the research the behavioral factors of the students was studied. According to the research made on the collected datasets from the learning management system, considering the demographic features, behavioral factors and academic backgrounds factors. The ensemble method was applied on the data sets. The results were also analyzed with and without the behavioral factors. But this study was made on the online learning not on the face to face learning. It showed that 80% accuracy was there in the student's performance in the online learning systems [58]. Another research was made to predict that which student is best for the mathematics subject, the two methods were used for the performance prediction

of the students including the SVM prediction model and k-nearest neighbor model, this helps us to select a particular student for a specific task. To find the association between the target values and grade the feature selection process was carried out. The results of both the methods were compared. The both results showed that both the models carried out for the performance prediction were almost same. But the k-nearest method showed slightly different results. It was noticed that SVM is good for small data sets and not for the large datasets [59]. Researchers have used prediction models for the student's academic performances for different subjects or courses. To classify and identify the students they have collected data of different student's parameter for a particular subject. The study was conducted on the student of Bachelor of computer science from UniSZA. In the study the three selected classification algorithms were compared including Rule Based (RB), Naive Bayes (NB) and Decision Tree (DT). This experiment consists of the duration of 8 years and contains 497 record from July 2007 to July 2014. Previous academic records, family background and the demographic features were included in the dataset. The accurate value was shown by the Rule based model which was 71.3%. This model is helpful for the instructors to assist the average category and poor students to improve their future performances. The data set was very simple and small and the study can be expanded to large datasets for accuracy. [60].

Researchers have used prediction models for the student's academic performances for different subjects or courses. To classify and identify the students they have collected data of different student's parameter for a particular subject. The study was conducted on the student of Bachelor of computer science from UniSZA. In the study the three selected classification algorithms were compared including Rule Based (RB), Naive Bayes (NB) and Decision Tree (DT). A research proposed different methods for the improvement in the learning capabilities in the educational institutes of the learners. This study is providing a guideline to the higher education system in successful decision making. The study aims to analyze the different factors that are affecting the learning behavior of a learner and his performance using k-means clustering algorithm [61].

2.7 Students Engagement and their Academic Outcomes

The diversity of the students and the ways in which the lectures are being given to them are analyzed to meet the outcomes and standards. It was concluded that the engagement of the students is very compulsory for the improved academic outcomes. In the results of the students the online learning material is playing an effective role. To get access to the online learning material is an indicator of the excellent performance of the students. The students studying in the one semester time consuming were compared with the part time studying students who spent years in their education because of lack of time. Those students who have online access to the courses on regular were having good marks and better assessment records. It is said that participation level and proficiency has strong associations. The male students were more in number in the full time courses and the females were more in the half time courses. The research showed that time is the major factor in the good performance of the students and also the access to online lectures is also the main factor in the well performance of the students [62].

During the COVID-19 pandemic the researcher has studied the perspective of the Higher Education Commission regarding the digital and distance learning courses of universities. The postgraduates and undergraduates students were evaluated to study their views related to the online learning environment. In this study there were total 126 students, out of them 42 were males and 84 were females. Two factors were studied i.e., in Pakistan the apprehension of the strength of the online learning environment from the HEC student's aspect and the other factor is to show the tribulations and trials of online learning environment challenged by the students of Pakistan. In a study, the responses of postgraduates and undergraduates students were studied because they were currently appearing in the online classes and also there were some students who have done with the last semesters in the online systems. In a study, the responses of postgraduates and undergraduates students were studied because they were currently appearing in the online classes

and also there were some students who have done with the last semesters in the online systems.

The survey was conducted online in which the data related to students viewpoint regarding online learning environment was collected. According to 78.6% students the person to person communication is very efficient for the students in distance learning and traditional learning. The studies showed that in the underdeveloped countries like Pakistan the online learning environment is not effective at all, but it is effective in the other digitally developed countries. Because in Pakistan most of the students have no access to the internet and also some students are not having proper electronic devices for taking the online classes. And also in the online learning environment as per the students there is no interaction with the teachers so it is also a problem for them [63]. A new disease COVID-19 has been spreading day by day all over the world including Pakistan, it is spreading from one person to another. In this pandemic situation, the WHO had decided the lockdown throughout the world.

In Pakistan the schools were closed so most of the educational institutes were converted to the digital learning system. Because education is very necessary for the socialization of any society. As due corona virus the traditional education system was stopped, its place has been taken by digital education system. There was a survey conducted in Lahore Pakistan to study the factors of the online education system. The aim of this survey was to find out that what the acceptance rate of the online classes is and also to highlight the phases that are affecting the online learning environment. Also to give the ideas for making the online learning environment efficient. The questionnaires were filled by 240 students who were attending the online classes. The results showed that many students were satisfied with the online classes and they recommended that Government should inform the students earlier about the change in the education system so that students get prepared for it [29]. In Saudi Arabia, a research was done on the online learning environment of the medical college students in Riyadh Alfaisal University in March 2020 and April 2020. There were total 1289 students and faculty members involved in the research and the questionnaires were made using

online Google forms. The students and faculty members participating in the survey were 54.8% females, 14.9% were students of masters, 66.8% were medical students and faculty members were 18.3%. Before pandemic 41.8% responders were having no online learning/teaching experiences and 62.5% responders favored the face to face and online learning. The medical college students are facing a lot of challenges during the COVID-19 pandemic and the online learning system. These challenges include the student assessment, communication, and pandemic related stress, use of technology tools, time management, technophobia and online experience. Beside all these challenges many of the responders thought that the COVID-19 pandemic is proved to be their confidence booster and it is very effective in the online medical education. In short, it was observed that there are challenges regarding the online learning environment but it is the modern teaching and learning education system and is having positive impacts on the medical education [64].

2.8 Summary of Review of Literature

Students are the main sponsors of any institution and they contribute in economic and social growth of a country which leads to produce creative graduates, modernizers and Entrepreneurs. It is obvious that the use of learning management system has been increased and as a result institutes contain wide-ranging dataset storing various aspects related to student's academic performance.

The performance data can be helpful to increase the success of the students by taking immediate steps based on the previous feedback instead of relying on the experiences. This analysis can help the students, instructors and educational institutes to predict the failure and success of the students during the COVID-19 pandemic situations and in the switch of traditional education system to virtual learning environment and their overall improvement in the educational outputs.

The students are facing a lot of problems because the education system has been switched to the virtual learning environment. Many factors are involved in causing the poor performance of the students. Many factors are involved in causing the poor performance of the students. It has been seen that some of the students do

TABLE 2.1: Summary of Impacts of COVID-19 on Virtual Learning Education.

Ref	Features			Techniques			Datasets		Problems			VLE	
	A	B	C	A	B	C	A	B	A	B	C	A	B
[64]	y					y	y	college			y	y	
[29]	y			y			y	uni		y		y	
[63]			y			y	y	uni	y	y	y		y
[56]		y		y			y	school	y		y		y
[52]	y					y	y	school	y			y	
[55]	y				y		y	uni	y			y	

A. Impacts of VLE on Education
 B. Comparison of VLE and TES
 C. Challenges faced during VLE

A. SPSS
 B. ANOVA
 C. Other Statistical Analysis

A. Online Questionnaire
 B. Educational Institutes

A. Internet access
 B. Lack of electronic devices
 C. Unable to use electronic devices

A. VLE is Effective
 B. VLE is not effective

TABLE 2.2: Summary of Students Performance Using Prediction Models

Ref	Features Category				Classifier or Model						Ensemble			Dataset		
	A	B	C	D	A	B	C	D	E	F	A	B	C	A	B	C
[8]		y			y	y		y	y	y					school	78%
[9]		y	y	y	y	y				y	y	y	y		lms	Y
[10]		y								y						
[11]		y	y	y				y	y					33	school	-
[16]	y	y	y		y	y	y							9	uni	86%
[12]		y								y				7	uni	98%
[17]		y	y	y	y	y		y	y	y	y	y	y	17	sch	94%

A:Pre-Academic Record
 B:Academic
 C:Demographic
 F:Behavior

A:Decision Tree
 B:NaiveBayes
 C:RuleBase
 D:KNN
 E:SVM
 F:Others

A:Bagging
 B:Boosting
 C:others

A: No. of Features
 B:Data
 C: Accuracy

not understand the lecture at all during the virtual learning environment sessions rather students spend a lot of time in understanding the virtual learning equipment. That's why it is very necessary to find out the students who are at risk at early stages of the virtual learning environment so that the immediate steps can be taken to improve their academic performance in future. In depth analysis of literature on the prediction of different features/factors of the performance

of the students. Different courses are designed by the instructors so the existing prediction models are of generic nature and can't handle the course to course diversity.

In the papers studied for the review of literature, the main research was about the prediction of the student's performance and their engagement during the online classes. The gap in the research were to compare their academic record in the traditional education system and the online learning environment and also the problems faced by the students of Pakistan in attending the online classes. The major focus of this research was to study the problems faced by the BS and MS students during virtual learning environment at the ABC university and on the performance of the different prediction models for the performance of the students with an objective of identifying that the academic record of virtual learning environment is best or that of traditional education is best. Prediction analysis was used to focus on the impacts of virtual learning environment on the Spring 2020 and Fall 2020 semesters.

Chapter 3

Methodology

In the COVID-19 lockdown situation, the traditional education system of almost all universities shifted to virtual learning environment. Most of the private and public university in Pakistan followed TES and many of student in Pakistan belong to TES. But when the pandemic situation came, the university made all the arrangements for delivering lectures to students through online learning environment because they wanted to save the student's time. But some of the students of university also belonged to such areas where there is no internet access so a lot of students were facing problems in attending online classes.

So there was a need for this purpose we contacted a local university that whose name we are not mentioning for the sack of privacy so from now we name that ABC university. The ABC university, Islamabad used the Microsoft Teams for delivering the lectures to their students, for their assessments and exams. Microsoft Teams is the software used for the communications in the business and it is generated by the Microsoft, it is the part of the products Microsoft 365 family [65].

There were two research questions that were answered in this research work. In order to answer research question 1 (RQ1) 2 approaches were followed i.e., survey of comparison of TES and VLE, and the other approach was the student's feedbacks regarding the understanding of the VLE lectures. For research question 2 (RQ2)

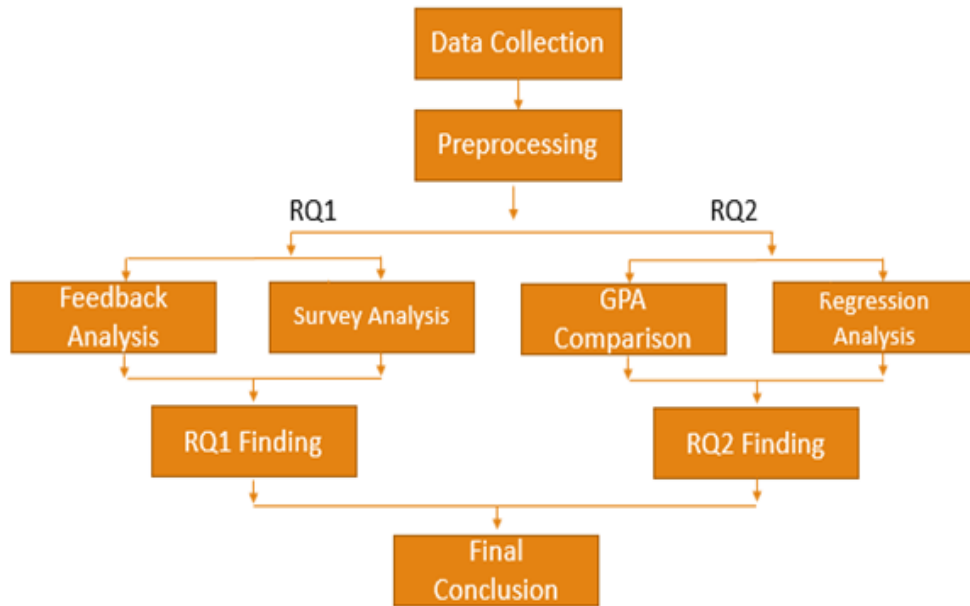


FIGURE 3.1: Methodology

2 approaches followed were the comparison of the GPA of students, and the other was the prediction of the academic record of the students.

RQ1: What is the impact of VLE on the understandability of students and problems faced by students during VLE?

Different problems were faced by the students during online classes. Some of the students of ABC university belong to such areas in Pakistan where there is not internet. So some students were not having proper access to internet as a result their attendance issue arises, some people were having a difficulty in understanding the lectures through online teaching methodology. Some students were not having any problem with the online teaching. By using Google Forms, a questionnaire was designed so collect the data from the students through online Microsoft Teams. The questions were regarding the understanding of lecture and the problems faced by students during VLE semester. The data was taken from the students of ABC university.

A survey was conducted to ask the students that they want to study in the traditional education system or they want to follow the same virtual learning environment for their further education. The questions were asked about the difference

Subject ABC
Capital University of Science & Technology, Islamabad
* Required

Following topic were covered in today lecture; please ticks the you understood well? *

Topic A
 Topic B
 Topic C

If you could not understand any topic(s), please mention the reason?

Internet Issue
 Electricity Issue
 Topic was Difficult
 No issue

FIGURE 3.2: Questionnaire of the Feedback

they feel in the traditional education system and virtual learning environment. In this survey multiple questions were asked from them which include the questions related to the skills improved in the online classes or they were better in the traditional education system, the electronic devices they used for their online classes and also about their academic records in the VLE.

3.1 Dataset of Student's Feedback and Survey Conducted

In this research the feedbacks from the students were taken related to every lecture of 41 subjects. The students filled the online feedback forms provided to them by their subject's teachers on Microsoft teams and then the data was collected from their teachers and then was analyzed using different statistical methods. The feedback was taken after every online lecture from the students of BS and MS (CS and SE) of ABC university during the spring semester 2020 in which the virtual learning environment was followed by the ABC university for the Online Classes

during COVID-19 pandemic to save the time of students. The total subjects of the BS program selected for the research feedback were 42 and the MS subjects selected were 3. The total students enrolled in some subjects were 15 and in some courses there were 52 students in each lecture. The questionnaire consists of the different questions shown in the appendix.

In the last week of the semester Spring 2020 which was based on the virtual learning environment, a survey was conducted in the ABC university from the 495 BS students of computer science department. The survey was performed to check the difference between the traditional education system and virtual learning environment, that how the students feel about the virtual learning environment, or whether they want to continue the learning through the VLE. Out of 495 students, 24.6% were female students and the male students were 75.4%. The questions included in this survey were about the digital tools used during online classes. The purpose of asking this question was to know about the devices they used for attending the online classes. The other question was about their access to internet, quiet place, electricity and their comfort ability with the digital tools the results are shown in the figure ???. The other question was about the comparison between the TES and VLE including the clarity of concepts, class discipline, class interaction etc., and our purpose of asking this question was to check the students' response about VLE. The results are shown in the figure ???. Another question was about the comparison of their problems handling during the TES and VLE, the results are shown in the figure ???. The last question was about the students' feeling regarding the VLE that they like online classes or not. The purpose of asking was to check the percentage of student who like the VLE so that the decision about the VLE confusion could be made even after the COVID-19 over.

3.1.1 Pre-processing

After the collection of the datasets, the preprocessing is an important step to get the accurate data and to remove the noise from the data. It involves the different steps like data cleaning, data transformation, feature selection and reduction of the data. In this research, different teachers used different terminologies to get

the feedback from their students like some were using the words' lack of access to internet, some were using the words like no internet. So there was a need of preprocessing the data. The feedback was taken from the students after every online class. In this step, the use of different terminologies was brought to constant words. In this research, all of the samples of the original data are included. A low percentage of the noisy data was found in the data. The duplicated values and missed values in the feedback were removed from the data record. In the survey data, some students submitted the same response which means their response was duplicated and in some students survey data the values were missing. So there was a need of preprocessing the data.

3.1.2 Data Cleaning

Data cleaning is an important step in the preprocessing of the data. The purpose of the data cleaning is to remove the noise from the data, also to remove the irrelevant data and also dealing with the missing values. Due to the absence of the data for any feature the problem of missing data arises. In the process of data collection if one gets the irrelevant data then it is called noise in the data. In the data cleaning step the response of the survey which was taken from the 495 was reduced to 472 student's response.

3.1.3 Data Analysis

The data analysis was done by Python language codes. After that the data was cleaned by applying manual formula on the Excel sheet and the percentage of the various problems faced by the students during the virtual learning environment, attendance of students and the student's understanding of the lectures was found. The percentage of each subject was found separately and then the overall parameters were analyzed. The graphs were made which are discussed in the results. This was a very huge data so for this purpose different statistical analysis was done to analyze the data. The data analysis was done by using SPSS software and Excel sheet, the percentage was taken by the help of SPSS software while the graphs were made by the help of Excel sheet.

RQ2: What is the comparison of the student's academic performance in traditional education system and virtual learning environment?

For the comparison of the academic performance of students, the data of GPA of three semesters i.e., Spring 2019, Fall 2019 and Spring 2020 of different students was taken from the ABC university. A comparison of traditional education system and the virtual education system was done. For this purpose firstly the GPA of two semesters of traditional education system was compared and then this result was compared with the semester based on Virtual learning environment to check that the traditional education system was good or the Virtual learning environment was good. Prediction of the final results of the semester Fall 2020 was done, for this purpose the data of quizzes, assignments and Midterm marks was taken from the ABC university of three semesters was taken which includes the Fall 2019, Spring 2020 and Fall 2020. The data was of multiple subjects of these semesters. The purpose of the prediction of final results of the students was to check the impacts of the virtual learning environment on the academic performance of the students.

3.2 Dataset of Students GPA and Prediction of Students' Final Marks

The GPA data was collected of the BS and MS students from the ABC university. The data was of three semesters i.e., Spring 2019, Fall 2019 and Spring 2020. The data was kept secret because it was a confidential data and it should not be shared with anyone. The data taken was of multiple Batches to check the variation in the results that what is the difference in the TES semesters GPA of the students, and how much the VLE has affected the academic records of the students of the ABC university, because of different problems faced by them in attending the online classes. The data collected was of different types, the data was in the form of student's marks in the assignments, quizzes, Midterm Exams and Final Term Exams of the Fall 2019 semester which was based on the traditional education system. The data was kept secret because it was a confidential data and it should

not be shared with anyone. The marks of assignment, quizzes, Midterm and Final Term of the total 31 subjects each having different sections were collected. The data of this semester acts as the training model for the research. Then the data of the marks of the assignments. Quizzes, Midterm and Final term of the student's 40 subjects in the semester Spring 2020 was collected which was based on the virtual learning environment. This data acts as the test model for the data of the Fall semester 2019. After that the data of the marks of the assignments, quizzes and Midterm of the semester Fall 2020 based on the virtual learning environment was collected. The Final term marks of the Fall 2020 were unknown and they were predicted using different statistical methods. The data of the Fall 2020 acts as the test model for the Spring 2020 semester and the final marks of the Fall 2020 were predicted of the 12 subjects.

3.2.1 Data Preprocessing

After the collection of the GPA data of the students, the preprocessing was an important step to get the accurate data and to remove the noise from the data. It involves the different steps like data cleaning, data transformation, feature selection and reduction of the data. The data provided for the research was in the PDF files, that data was converted to Excel sheet and then the pre-processing was done manually. The data was very huge and only the data of those students was selected whose names were common in the three semesters.

The data was preprocessed in such a way that the 2 quizzes, 2 assignments out of first 4 were selected and the total quizzes and assignments taken by each student were 8, the marks of first 2 quizzes and assignments were selected for the data to be unbiased. The Midterm marks and Final marks were added and then the data of all the subjects of the Fall 2019 semester was merged. Then the 4 quizzes and assignments were selected out of the 8 quizzes taken by each student in the Fall 2019 semester and also the Midterm and Final term marks data was collected. After that the data of Spring 2020 semester was collected. 2 assignments and 2 quizzes out of the first 4 taken were selected for the unbiased data. The Midterm and Final term marks data was also collected. Then a separate file of every subject

was created and the best 2 quizzes and assignments marks were merged to run that as the training model. Then the marks data of the Fall 2020 semester was collected of the 2 assignments, 2 quizzes and Midterm exam was collected which was also based on the virtual learning environment. But the Final term marks were unknown and had to be predicted in this research. But the Final term marks were unknown and had to be predicted in this research. Preprocessing plays a very important role in the collection of the academic records of the students during the virtual learning environment and also the academic record of the traditional education system of the students was also collected to compare their performance in the TES semester Fall 2019 and VLE semester Spring 2020.

3.2.2 Data Cleaning

Data cleaning is an important step in the preprocessing of the data. The purpose of the data cleaning is to remove the noise from the data, also to remove the irrelevant data and also dealing with the missing values. In the process of data collection if one gets the irrelevant data then it is called noise in the data. In the data cleaning step of the BS data total students were 550 but they were not common in the three semesters so the common students selected were 453 out of the 550 because these students were continuing the education from the same ABC university and the other students have completed their degrees. In case of the MS students data, there were total 120 students whose GPA data was taken but the same issue was there that some of them were pass out so in the data cleaning step total 87 students were selected for analyzing their GPA. In the data cleaning the data of the students who have withdrawn their courses were excluded of all the three semester's data. Also those students were excluded who have not taken two quizzes or some students were not taken one quiz in the Fall 2020 because the data of this semester was not complete. Data cleaning is an important step in the preprocessing of the data. The purpose of the data cleaning is to remove the noise from the data, also to remove the irrelevant data and also dealing with the missing values. In the process of data collection if one gets the irrelevant data then it is called noise in the data.

3.2.3 Data Analysis

The data analysis was done by using Excel sheet. Different values were set according to which the increase or decrease in the GPA was analyzed. The values were set on this basis that if a student has 2.00 GPA in one semester and he got 2.02 or 1.98 in the next semester then that GPA was considered as equal GPA. It means that the difference of the 0.02 was not selected as the increase or decrease value. But if the GPA increased or decreased is above or below this value then that was considered as increased or decreased GPA. WEKA stands for Waikato Environment for Knowledge Analysis. It contains a lot of algorithms and visualization tools for the predictive modeling and data analysis for the easy access to these functions. It is a powerful tool for the development of machine learning models. In this research through the WEKA, the test models were applied on the training models and the accuracy of the results were obtained. Linear Regression technique was used in WEKA to check accuracy. One of the file having the best attributes was selected of the Fall 2019 semester and this file acts as the response variable for the data of the Fall 2020 semester. After that the data file having best attributes of the marks of Spring 2020 semester acts as the response variable for the data of the Fall 2020 semester. Then the codes were generated on the Python language to predict the unknown marks of the Final term of 12 subjects of Fall 2020 semester. The graphs were made and shown in the results.

3.2.3.1 Linear Regression Model

Linear Regression models are the modelling between independent and dependent variables. In the linear regression model if there is only one independent variable then it is called simple linear regression model. But in the linear regression model if there are more than one independent variable then it is called the multiple linear regression model [66]. Then the Linear Regression was applied on the data to find out the accurate marks of the 12 subjects of the Fall 2020 semester.

VLE system was adopted during the semester Fall 2020, because the government allowed 50% attendance on campus and 50% education through online classes.

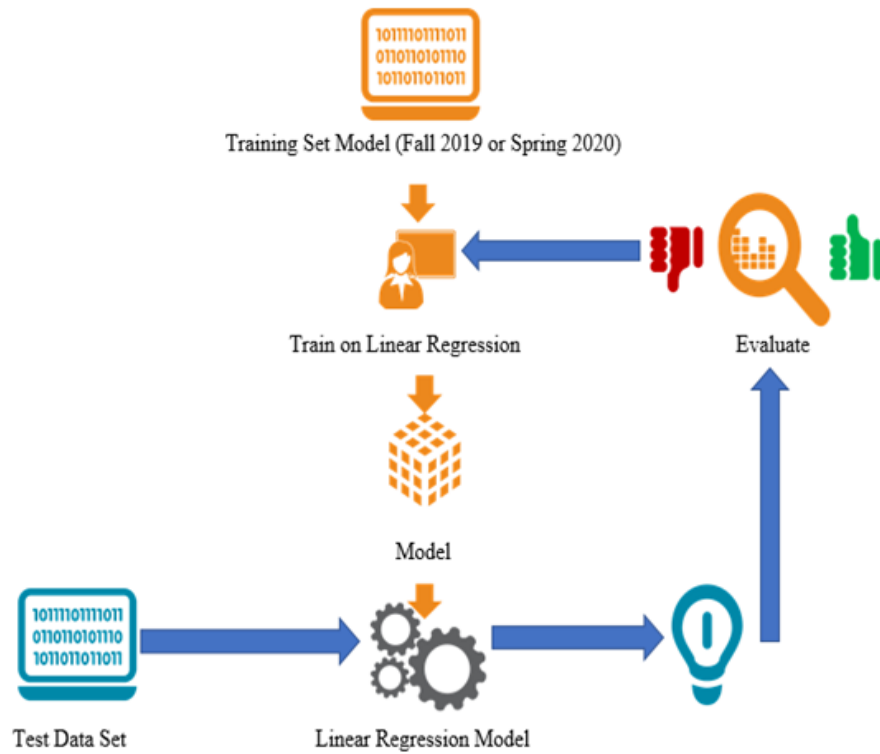


FIGURE 3.3: Model for VLE System during Covid-19

The hybrid education system was also adopted by the ABC university to save the time of students. That's why the final marks of the hybrid semester i.e., Fall 2020 were predicted in this research. The purpose of predicting the final marks was to check the academic performance of the students during the hybrid education system.

Chapter 4

Results

In this pandemic situations, it was very important for the researchers to know the student's problems of the ABC university because a lot of students belong to such areas where they have no access to internet and they have no facility of electricity. So for this purpose this research focuses on the detection of the problems of students during virtual learning environment. So for this purpose this research focuses on the detection of the problems of students during virtual learning environment, prediction of the student's academic record of Fall 2020 semester and also to compare the academic records (GPA) of the students in the online system and traditional education system. In this chapter the results of the research has been discussed. The RQ1 of the research focuses on the impacts of the virtual learning environment on the performance of the students. The feedbacks were taken from the students by the teachers through online forms and also the survey was conducted to check the problems of the students and the results.

4.1 Results of the Feedback

The feedbacks were taken from the students by the teachers through online forms and also the survey was conducted to check the problems of the students and the results are given in this chapter. Firstly, the results of the Feedbacks are discussed in this chapter.

4.1.1 BS Subject Discrete Structure Results

The data of thirteen lectures of BS of the subject Discrete Structure was taken and the feedbacks were taken from the students and their results are discussed in this section. The results of the feedbacks are shown in the following graphs.

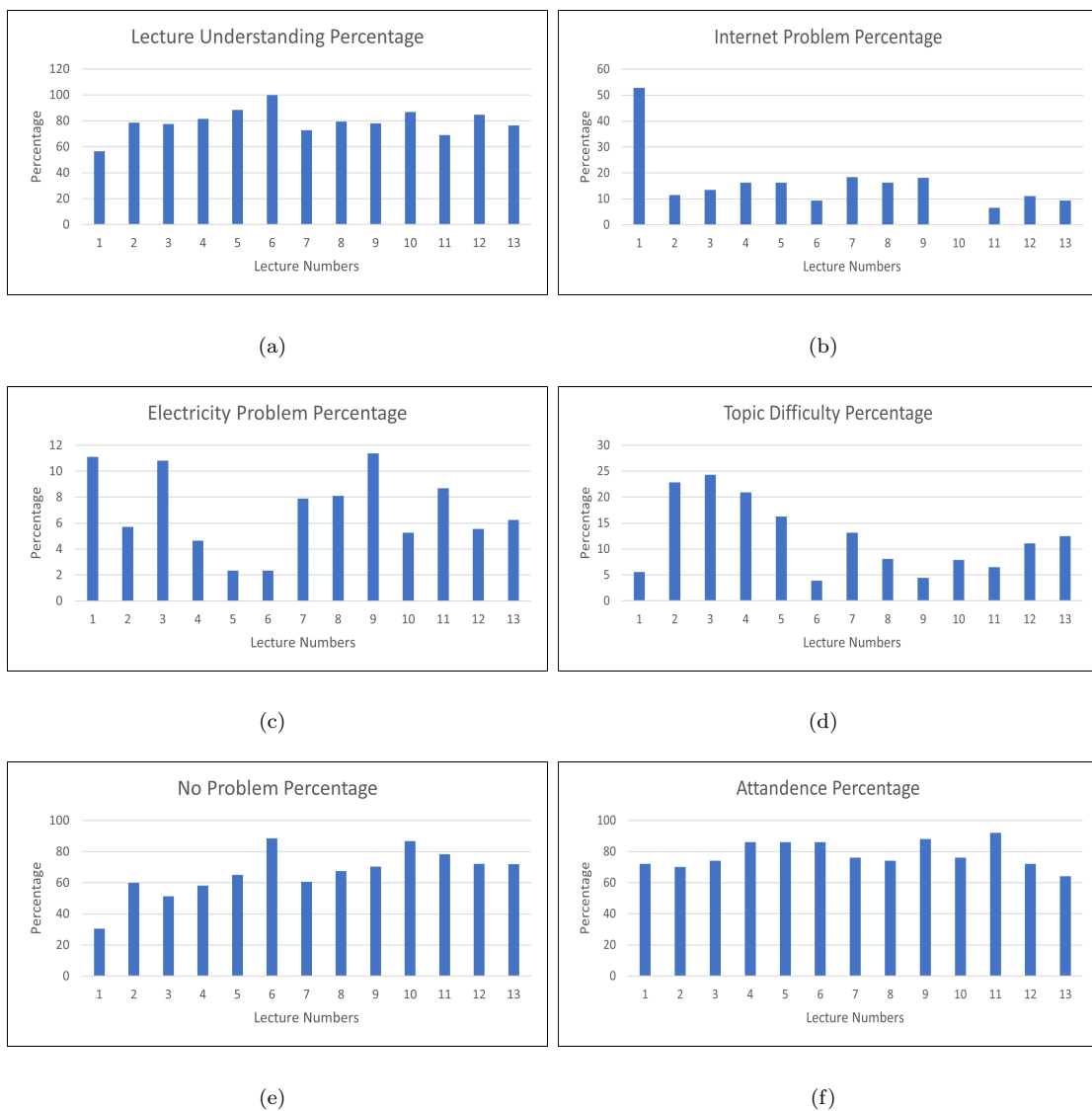


FIGURE 4.1: (a) Percentage of Understanding of Lecture by Students (b) Percentage of Internet Problem faced by Students (c) Students Faced Electricity Problems (d) Students Found the Lecture Topic Difficult (e) Students Faced No Problem During VLE (f) Attendance of Students

In graph 4.1 (a) 13 lectures data is shown in this graph and from the graph it is noted that the understandability of lecture 6 is highest, the understandability of

the first lecture is lowest and the average understandability of all the lectures is 79%.

In graph 4.1 (b) The highest number of students faced internet problem was during the lecture 1, the lowest number of students faced the internet problem during the lecture 10 and the average of students faced internet problem during VLE is 19%.

In graph 4.1 (c) During the lecture 1, 2 and 9 the students are having electricity problem, during the lecture 6 the students faced lowest electricity problem and the average of students facing the electricity problem is almost 6% according to this graph.

In graph 4.1 (d) The students found the topic of lecture 3 as difficult one, the students found that the topic of lecture 6 was not difficult. The average of the students found the lecture topic difficult is almost 14% according to this graph.

In graph 4.1 (e) During the lecture 6, there was no problem faced by the students, the lowest percentage of the students facing no problem in the VLE are in the lecture 1 and the average of the students facing no problem during VLE is almost 70% according to this graph.

In graph 4.1 (f) The highest attendance was noted in the lecture 11 and the average attendance of the students during the VLE was almost 75%.

4.1.1.1 Findings on Individual Subject

From the above graphs, following findings have been established

- Lecture 6 was having highest understanding which was almost 100%
- In the same lecture, when other factors were seen, these problems were very less during the lecture 6, i.e. internet problem, electricity problems, difficult topic. The attendance rate was also higher in lecture 6. The topics covered in this lecture were example Ceaser cipher, Shift cipher and Affine cipher, which means either these topic were easy or they have been explained very well

- Now if we compare the lowest understanding lecture i.e. lecture 1, it is known that the electricity problems, internet problems, were on the peak. It means the problem in the lecture was of infrastructural nature, so the topics could have been covered by repeating in the next lecture. Average understanding in this course was 79%, average attendance was 78% and average of total marks were 72%
- “Topic Difficulty” seems higher in the initial lectures, however, the average of this factor is quite low in the later lectures. The initial rise in this factor may be due to the problem in the adjustment with VLE. So if VLE is continued in the next semesters this factor may have less impact
- Electricity problem for this course had been 6.9% which is quite reflect of electricity problem in our country
- Average of internet problem had been 15.3% which is very high and serious in the context of VLE. This clearly emphasizes that if VLE is to be continued then internet facility needs to be improved
- Topics with lower understanding were in lectures 7 and 11 which were Big O, practice problems of time and also complexity and binary operations. These topics should be given more emphasis in the next semesters

The feedback provided this much information about individual subjects, and this could be handed over to the teachers teaching these courses in the next semester and they can use this information for better delivery of the courses.

In order to give an overall view of the findings from feedback obtained on different subjects, below is the average of these factors.

4.1.2 Average of the Problems Faced by BS Students during VLE

The average of the problems faced by the BS students during VLE are shown in the following graphs, these results include the overall problems faced by the students

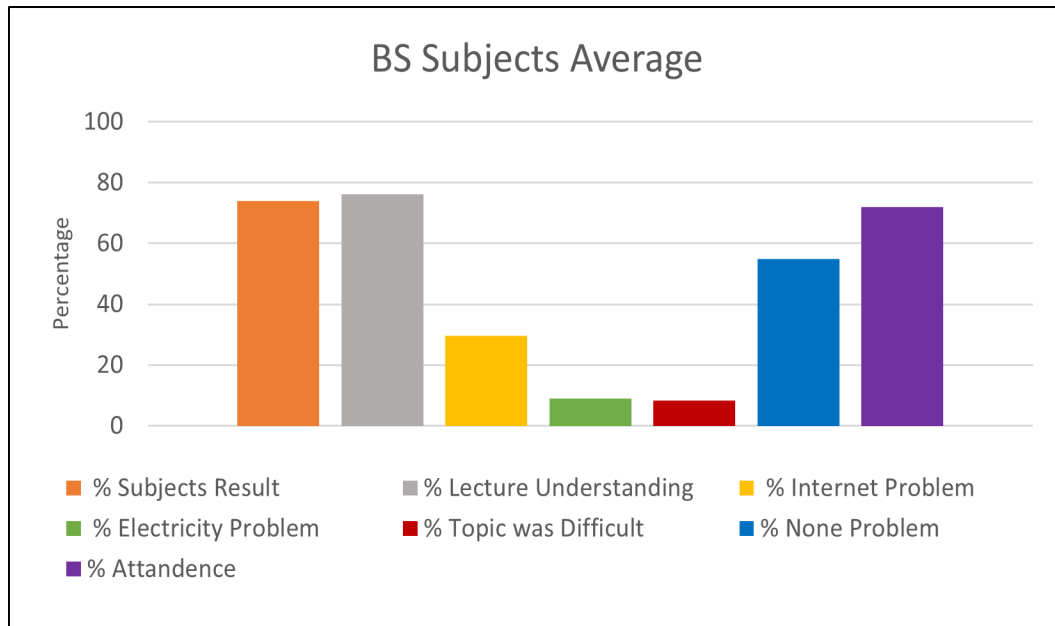


FIGURE 4.2: Problems Faced by BS Students during VLE

and also the data was categorized into males and females students to check their problems during VLE.

In graph 4.2 the average of the problems faced by students of BS are shown. The overall results of the subjects are 74%, the understandability of the lecture is 76%, the internet problem is 29%, the electricity problem is 9%, the students found the lecture topic difficult was 8%, the students having no problem are 54% and the attendance was 72% during the virtual learning environment.

In graph 4.3, for boys the overall subject results were 74%. Lecture understanding was 75%, the internet problem was 36%, electricity problem was 13%, boys found the topic difficult were 11%, boys faced no problem during VLE were 45% and the attendance during VLE is 70%.

While for girls the overall subject results were 69%. Lecture understanding was 68%, the internet problem was 28%, electricity problem was 7%, girls found the topic difficult were 11%, girls faced no problem during VLE were 46% and the attendance during VLE is 71%.

The average of the problems faced by the students was higher because during the VLE there were a lot of problems faced by the students. From the graphs where

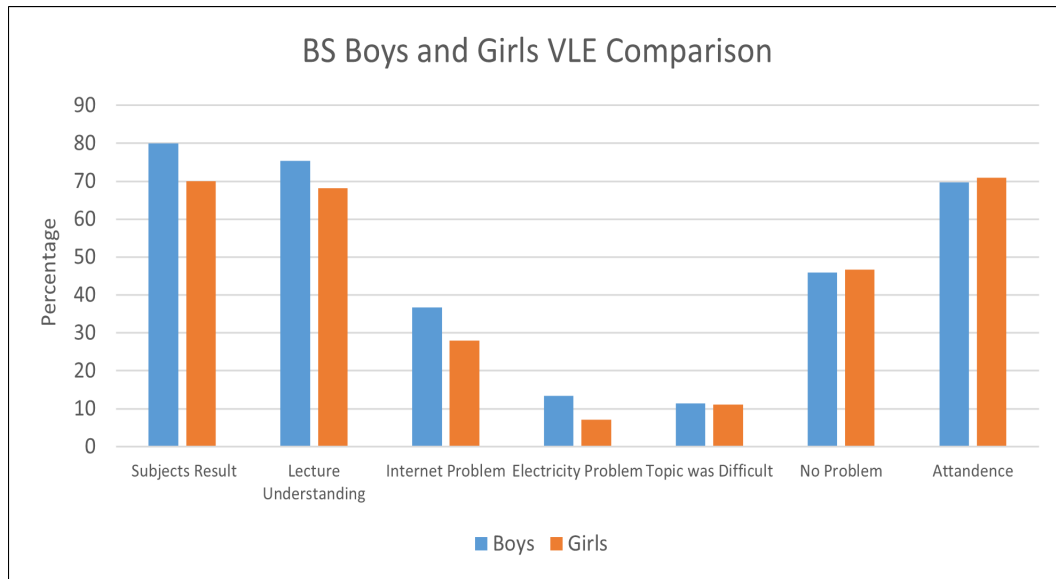


FIGURE 4.3: BS Boys and Girls VLE Comparison

the average of the overall subjects is shown, it is noted that the results of overall subjects were affected by the other factors like internet availability, electricity problems and as a result the students were not able to attend the classes, or they did not get the lecture from the online system. That's why the results of students were affected. The average of the problems faced by the students was higher because during the VLE there were a lot of problems faced by the students.

4.1.3 MS Subject Web-Knowledge's Results

The data of thirteen lectures of MS of the subject web-knowledge was taken and the feedbacks were taken from the students and their results are discussed here.

In graph 4.4 (a) Seven lectures data is shown in this graph and from the graph it is noted that the understandability of lecture 7 is highest, the understandability of the 6th lecture is lowest and the average understandability of all the lectures is 73%.

In graph 4.4 (b) The highest number of students faced internet problem was during the lecture 6, the lowest number of students faced the internet problem during the lecture 7 and the average of students faced internet problem during VLE is 25% as internet connection was not consistent..

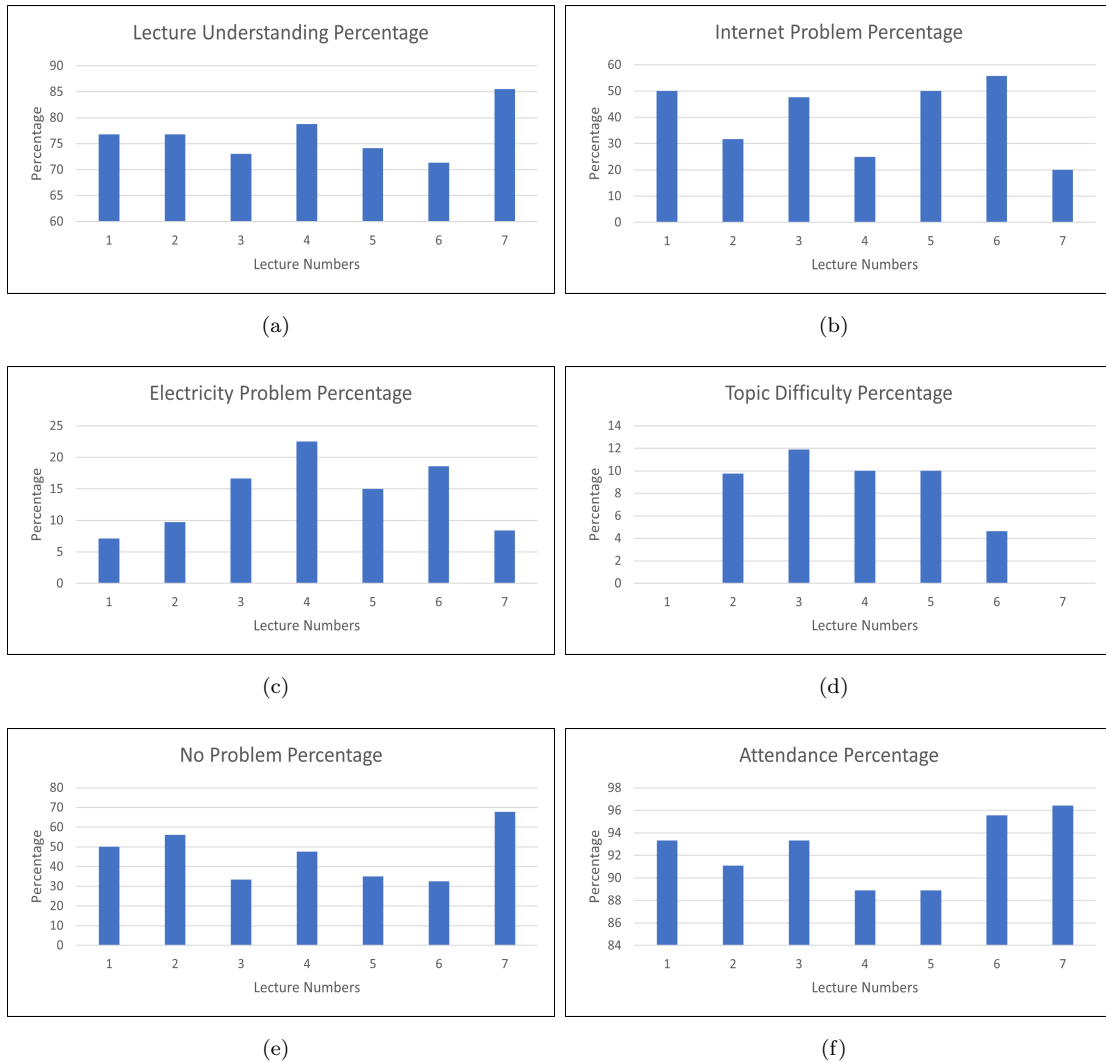


FIGURE 4.4: (a) Percentage of Understanding of Lecture by Students (b) Percentage of Internet Problem faced by Students (c) Students Faced Electricity Problems (d) Students Found the Lecture Topic Difficult (e) Students Faced No Problem During VLE (f) Attendance of Students

In graph 4.4 (c) During the lecture 4 the students are having electricity problem, during the lecture 1 the students faced lowest electricity problem and the average of students facing the electricity problem is almost 6% according to this graph.

In graph 4.4 (d) The students found the topic of lecture 3 as difficult one, the students found that the topic of lecture 7 was not difficult. The average of the students found the lecture topic difficult is almost 10% according to this graph.

In graph 4.4 (e) During the lecture 7, there was no problem faced by the students, the lowest percentage of the students facing no problem in the VLE are in the

lecture 6 and the average of the students facing no problem during VLE is almost 30% according to this graph.

In graph 4.4 (f) The highest attendance was noted in the lecture 7 and the average attendance of the students during the VLE was almost 89%.

4.1.3.1 Findings on Individual Subject

From the above graphs, following findings have been established

- Lecture 7 was having highest understanding which was almost 86%
- In the same lecture, when other factors were seen, these problems were very less during the lecture 7, i.e. internet problem, electricity problems, difficult topic. The attendance rate was also higher in lecture 7. The topics covered in this lecture were social web, tagging, citation relations and metadata extraction from PDF, which means either these topic were easy or they have been explained very well
- Now if we compare the lowest understanding lecture i.e. lecture 6, it is known that the electricity problems, internet problems, were on the peak. It means the problem in the lecture was of infrastructural nature, so the topics could have been covered by repeating in the next lecture. Average understanding in this course was 76.63%, average attendance was 90.79% and average of total marks were 82.62%
- “Topic Difficulty” seems higher in the later lectures, however, the average of this factor is quite low in the starting and ending lectures. The initial rise in this factor may be due to the problem in the adjustment with VLE. So if VLE is continued in the next semesters this factor may have less impact
- Electricity problem for this course had been 15.44% which is quite reflect of electricity problem in our country
- Average of internet problem had been 44.31% which is very high and serious in the context of VLE. This clearly emphasizes that if VLE is to be continued then internet facility needs to be improved

- Topics with lower understanding were in lectures 3 and 6 which were TIERL algorithm, venue disambiguation, CAFSIAL - Framework, Aggregation Knowledge Base Layer, Property Aggregation Layer, CAFSIAL - architecture, aspect property retrieval, LOD - Applications. These topics should be given more emphasis in the next semesters

The feedback provided this much information about individual subjects, and this could be handed over to the teachers teaching these courses in the next semester and they can use this information for better delivery of the courses.

In order to give an overall view of the findings from feedback obtained on different subjects, below is the average of these factors.

4.1.4 Average of the Problems Faced by MS Students during VLE

The average of the problems faced by the MS students during VLE are shown in the following graphs, these results include the overall problems faced by the students and also the data was categorized into males and females students to check their problems during VLE.

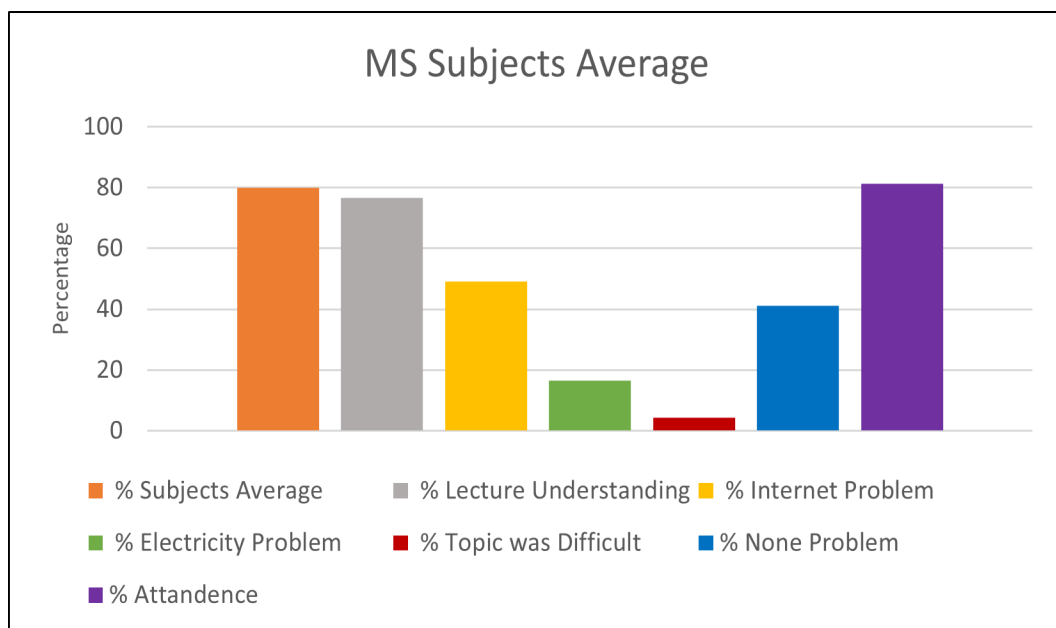


FIGURE 4.5: Problems Faced by MS Students during VLE

In graph 4.5 the average of the problems faced by students of MS are shown. The overall results of the subjects are 80%, the understandability of the lecture is 76%, the internet problem is 49%, the electricity problem is 16%, and the students found the lecture topic difficult was 4%, the students having no problem are 41% and the attendance was 81% during the virtual learning environment.

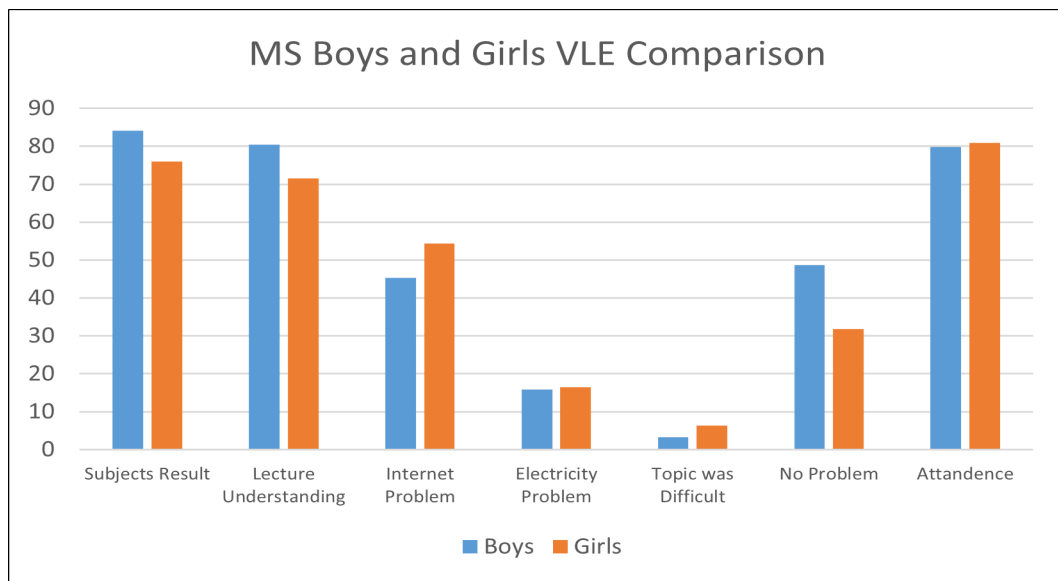


FIGURE 4.6: MS Boys and Girls VLE Comparison

In graph 4.6 the overall subject results are 84%. Lecture understanding was 80%, the internet problem was 45%, electricity problem is 15%, the students found the topic difficult were 3%, the students faced no problem during VLE were 48% and the attendance during VLE is 79%.

In this graph the overall subject results are 75%. Lecture understanding was 71%, the internet problem was 54%, electricity problem is 16%, the students found the topic difficult were 6%, the students faced no problem during VLE were 31% and the attendance during VLE is 80%.

The average of the problems faced by the students was higher because during the VLE there were a lot of problems faced by the students. From the graphs where the average of the overall subjects is shown, it is noted that the results of overall subjects were affected by the other factors liking internet availability, electricity problems and as a results the students were not able to attend the classes, or they

did not get the lecture from the online system. That's why the results of students were affected.

4.1.5 Correlation of Understanding of Students with Different Factors

Correlation was a major attribute of our feedback part of our research. The correlation was find out by the Excel sheet and the purpose of finding the correlation was to check that whether our results are accurate or not. And also to check the association of the understandability of the students with the different problems faced by them in VLE.

TABLE 4.1: Correlation of Understanding of Students with Different Factors

Sr.	Subject Name	Internet Problem	Electricity Problem	Topic Difficulty	No Problem	Attendance
1	Discrete Structures	-0.66	-0.77	0.032	0.71	0.24
2	Internet of Things	0.27	-0.76	-0.22	-0.28	0.21
3	Introduction to Computing	-0.64	-0.47	-0.85	0.87	-0.14
4	Block chain Technology	-0.52	-0.49	-0.12	0.66	-0.05
5	Operating System	-0.58	-0.47	-0.28	0.78	0.41
6	Machine Learning	0.51	-0.05	0.46	-0.55	-0.15
7	Average of All subjects	-0.57	-0.48	-0.45	0.77	-0.21

Co-relation for all the subjects lectures understanding was calculated with other factors involved in VLE. Discrete Structures co-relation of lecture understanding with internet problem calculated was -0.66. Internet of Things course lecture

TABLE 4.2: Gender of Students Responded to the Survey

Questions	Male	Female
Gender	75.4 %	24.6 %

TABLE 4.3: Device Used by Students during VLE

Questions	Laptop	Desktop	Mobile
Which device you have been using mostly for the classes?	62.8 %	8.9 %	28.2 %

understanding co-relation found with electricity problem was -0.76. Co-relation for Introduction to Computing lectures understanding with topic difficulty found was -0.85. Block Chain Technology subject lectures understanding co-relation with no problem faced was 0.66 while for Operating System course lectures understanding co-relation with attendance calculated was 0.41.

Similarly, for all the subjects lectures average co-relation of lectures understanding with internet problem was -0.57, with electricity problem -0.48, with topic difficulty -0.45, with no problem faces 0.77 and with attendance -0.21 was calculated.

4.2 Results of Survey

The survey was conducted in the last week of the VLE semester Spring 2020. Multiple questions were asked from the students through the web forms. 472 students responded and their results are shown in the tables.

According to the table, there were 24.6% females and the males were 75.4%.

In the table, 62.8% students were using laptops for attending the online classes, 8.9% students were using desktop (PC) for the online classes and the students using mobiles for the online classes were 28.2%.

In this table, three parameters are described, i.e., yes, no and sometimes. Students having a quiet place to study are 33.8%, the students do not having quiet place are 17.8% and the students sometimes have a quiet place are 48.4%. Students having a stable internet connection are 18.5%, the students do not having stable internet connection are 30.1% and the students sometimes have stable internet connection

TABLE 4.4: Access to the Internet, Quiet Place, Electricity and Digital Tools

Questions	Yes	No	Sometimes
A quiet place to study	33.8 %	17.8 %	48.4 %
Stable Internet connection	18.5 %	30.1 %	51.4 %
Smooth flow of electricity	27.4 %	34.2 %	38.4 %
Do you feel comfortable while using digital tools Teams Forms	37.2 %	27.4 %	35.5 %

TABLE 4.5: Agreeableness of students with the statements asked from them

Questions	Strongly Agree	Neutral	Not Agree
Online classes have improved your studies skills?	8.7 %	38 %	53.3 %
Your overall academic motivation before the transition to online class was high?	45 %	41.2 %	13.8 %
Your overall academic motivation currently is high in online classes?	11.7 %	46.9 %	41.4 %

are 51.4%. Students having smooth flow of electricity are 27.4%, the students do not having smooth flow of electricity are 34.2% and the students sometimes have a smooth flow of electricity are 38.4%. Students comfortable with digital tools for online classes are 37.2%, the students who are not comfortable with the digital tools are 27.4% and the students sometimes comfortable with digital tools are 35.5%.

In this table, three parameters are described i.e., strongly agree, neutral and not agree. The first question was “the online classes have improved your studies skills” The students who were strongly agree were 8.7%, neutral answers were 38% and those who were not agree were 53.3%. The second questions was “Your overall online motivation towards the online classes were high”. The students who were highly agree were 45%, neutral were 41.2% and do not agree students were 13.8%. The third question was “Your overall academic motivation currently is high in online classes”. The students strongly agreed were 11.7%, neutral were 46.9% and those who are not agree are 41.4%.

In this table, three parameters are described i.e., Option A better than on-campus classes, Option B same as on campus classes and Option C almost half compared to on campus classes. The first question was “clarity in understanding concepts”,

TABLE 4.6: Comparison of Online and On-Campus Classes, Better than on-campus classes, Same as on campus classes and Almost half compared to on campus classes are represented as Option A, Option B and Option C in table

Questions	Option A	Option B	Option C
Clarity in understanding concepts	5.7 %	18.7 %	75.6 %
Ease while taking quiz	15.9%	30.4%	53.7%
Ease in submitting assignments	25.1%	32.3%	42.7%
Content covered in one lecture	9.3%	43.9%	46.7%
Discussion during the lecture	10%	35.5%	54.6%
Voice of teacher is clear during class?	8.9%	36.1%	55%
Teachers' availability after class	28.5%	46.5%	25.1%
Class interaction	10.8%	33.3%	55.8%
Class discipline	19.3%	51%	29.7%
Labs understanding	7.6%	21.4%	70.9%
Level of Understanding of technical content	5.7%	20%	74.3%
Overall course coverage	6.8%	48.4%	44.8%
Semester workload	16.6%	47.1%	36.3%

students responded better were 5.7%, those saying that these were same were 18.7% and students saying that almost half were 75.6%. The second question was “easy while taking quiz”, students saying better were 15.9%, those saying same were 30.4% and almost half were 33%. The third question was “easy in submitting assignments”, the students saying better were 25.1%, and those saying same were 32.3% and those saying almost half were 42.7%. The Fourth question was “content covered in one lecture”, the students saying better were 9.3%, those saying same were 43.9% and those saying almost half were 46.7%. The fifth question was “discussion during the lecture”, the students saying better were 10%, the same were 35.5% and those saying almost half were 54.6%. The sixth question was “the voice of teacher is clear during classes”, the students saying better were 8.9%, those saying same were 36.1% and those saying almost half were 55%. The seventh question was “Teacher availability after class”, the students saying better were 28.5%, same were 46.5% and almost half were 25.1%. The eighth question was “Class interaction”, the students saying better were 10.8%, same were 33.3% and almost half were 55.8%. The ninth question was “class discipline”, the students saying better were 19.3%, same were 51% and almost half were 29.7%. The tenth question was “Lab understanding”, the students saying better were 7.6%, same 21.4%

and almost half were 70.9%. The eleventh question was “level of understanding of technical content”, the students saying better were 5.7%, same were 20% and almost half were 74.3%. The twelfth question was “overall course coverage”, the students saying better were 6.8%, same were 48.4% and almost half were 48.8%. The thirteenth question was “semester workload”, the students saying better were 16.6%, same were 47.1% and almost half were 36.3%.

TABLE 4.7: Comparison of Administrative Staff during Online classes and during TES

Questions	Option	Option	Option
	A	B	C
Complaints handling by department?	7 %	42 %	51 %
Complaints handling by controller office?	7%	46.3%	46.7%
Complaints handling by registration office?	6.2%	46.7%	47.1%
Complaints handling by accounts office?	6.6%	47.1%	46.3%
Complaints handling by VLE office?	7%	47.6%	45.4%

In this table, three parameters are described i.e., Option A better than on-campus classes, Option B same as on campus classes and Option C almost half compared to on campus classes. The first question was “complaints handling by department”, the students saying better were 7%, same were 42% and the almost half were 51%. In this table, three parameters are described i.e., Option A better than on-campus classes, Option B same as on campus classes and Option C almost half compared to on campus classes. The first question was “complaints handling by department” The second question was “Complaints handling by controller office”, the students saying better were 7%, same were 46.3% and almost half were 46.7%. The Third question was “Registration office”, the students saying better were 6.2%, same were 46.7% and almost half were 47.1%. The fourth question was “Complaints handling by accounts office”, the students saying better were 6.6%, same were 47.1% and almost half were 46.3%. The fifth question was “Complaints handling by VLE office”, the students saying better were 7%, same were 47.6% and almost half were 45.4%.

TABLE 4.8: Online Classes in Future

Question	Yes	No
Would you like to take the online classes in future?	37.8%	62.2%

In this table the students who want online education system in future were 37.8% and those who do not want the online classes in future were 62.2%. It means that students do not want any further study in the online education system.

The **RQ2** of the research was based on the comparison of GPA of the students and also the prediction of the final marks of the hybrid semester Fall 2020. The academic performance of the students was evaluated The academic performance of the students was evaluated during the traditional education system and virtual learning environment by collecting the GPA data.

4.3 Results of Comparison of GPA of BS Students Spring 2019 & Fall 2019

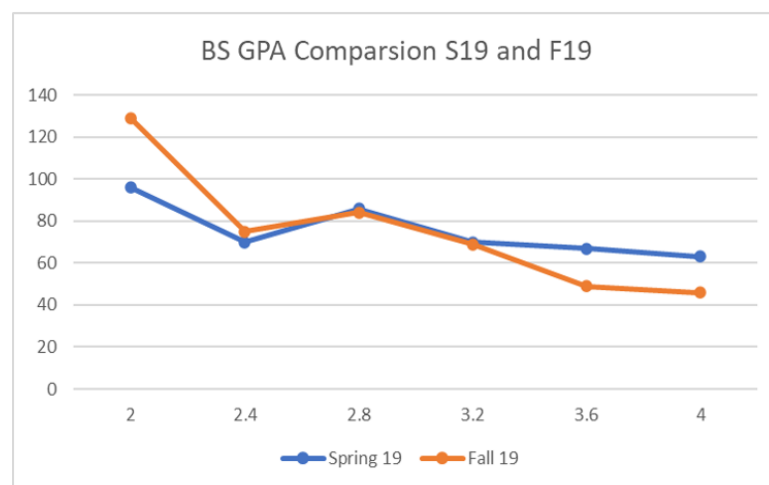


FIGURE 4.7: Comparison of GPA of BS Students of Semester Spring 2019 and Fall 2019 Based on TES

In figure 4.7, 453 students GPA comparison was performed for Spring 2019 and Fall 2019 semesters in which traditional education system was followed for both semesters. Most of students GPA was less than 2.0 in Fall 2019 as compared to

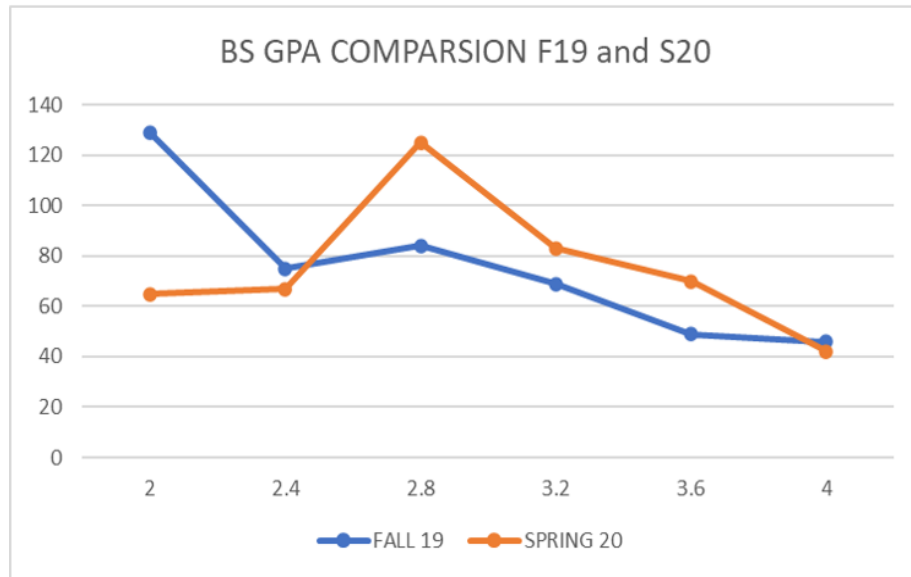


FIGURE 4.8: Comparison of GPA of BS students of Semester Fall 2019 Based on TES and Spring 2020

Spring 2019 semester. Most of students GPA was less than 2.0 in Fall 2019 as compared to Spring 2019 semester.

4.3.1 Comparison of GPA of BS Students Fall 2019 and Spring 2020

In figure 4.8, 453 students GPA comparison was performed for Fall 2019 and Spring 2020 semesters. VLE was followed for Spring 2020 while TES is followed for Fall 2019 semester. VLE was followed for Spring 2020 while TES is followed for Fall semester. Most of students GPA increased in Spring 2020 as compared to Fall 2019 semester.

4.3.2 Comparison of GPA of MS Students Spring 2019 & Fall 2019

In figure 4.9, 83 students GPA comparison was performed for Spring 2019 and Fall 2019 semesters in which traditional education system in which traditional education system was followed for both semesters. Most of students GPA was less than 2.8 in Fall 2019 as Most of students GPA was less than compared to Spring 2019 semester.

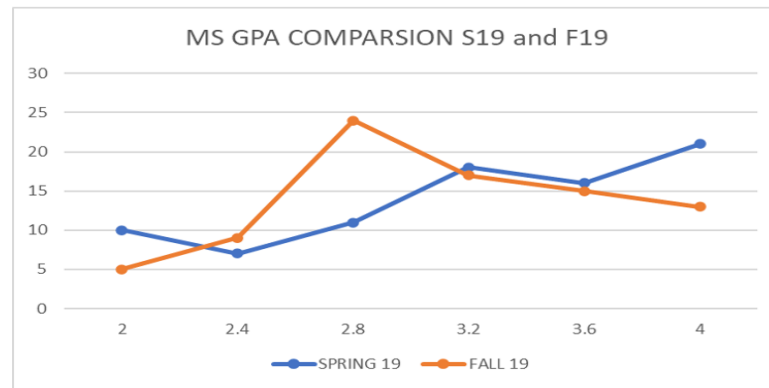


FIGURE 4.9: Comparison of GPA of MS Students of Semester Spring 2019 and Fall 2019 Based on TES

4.3.3 Comparison of GPA of MS Students Fall 2019 and Spring 2020

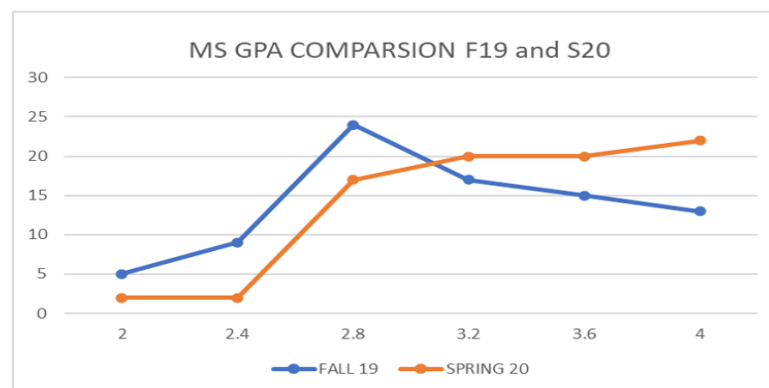


FIGURE 4.10: Comparison of GPA of MS students of Semester Fall 2019 Based on TES and Spring 2020

In figure 4.10, 83 students GPA comparison was performed for Fall 2019 and Spring 2020 semesters. VLE was followed for Spring 2020 while TES is followed for Fall 2019 semester. Most of students GPA increased in Spring 2020 as compared to Fall 2019 semester. Most of students GPA increased in Spring as compared to Fall semester. The comparison was done in the GPA of the students during two traditional education system semesters to check their GPA that whether it is decreased, increased or remains the same. The students whose GPA during the Fall 2019 was decreased were 47.8%, those whose GPA was increased were 20.1% and those whose GPA remained the same were 47.8%.

TABLE 4.9: GPA Comparison for BS and MS

Group	Comparison	Previous	New	Decrease	Same	Increase
BS	TES to TES	Spring 19	Fall 19	47.8%	32.1%	20.1%
	TES to VLE	Fall 19	Spring 20	17.9%	43.7%	34.7%
MS	TES to TES	Spring 19	Fall 19	44.6%	27.7%	27.7%
	TES to VLE	Fall 19	Spring 20	13.3%	41%	45.8%

The comparison was done in the GPA of the students during two traditional education system semesters to check their GPA that whether it is decreased, increased or remains the same. The students whose GPA during the Fall 2019 was decreased were 47.8%, those whose GPA was increased were 20.1% and those whose GPA remained the same were 47.8%.

The comparison was done in the GPA of the students of the traditional education system semester to the virtual learning environment semester Spring 2020 to check their GPA that whether it is decreased, increased or remains the same. The students whose GPA during the Fall 2019 was decreased were 17.9%, those whose GPA was increased were 47.3% and those whose GPA remained the same were 43.7%.

The comparison was done in the GPA of the students during two traditional education system semesters to check their GPA that whether it is decreased, increased or remains the same. The students whose GPA during the Fall 2019 was decreased were 44.6%, those whose GPA was increased were 27.7% and those whose GPA remained the same were 27.7%.

The comparison was done in the GPA of the students of the traditional education system semester to the virtual learning environment semester Spring 2020 to check their GPA that whether it is decreased, increased or remains the same. The students whose GPA during the Fall 2019 was decreased were 13.3%, those whose GPA was increased were 45.8% and those whose GPA remained the same were 41%. From the comparison of the GPA of the students of BS and MS students, it was seen that the GPA of students was increased in the virtual learning environment

but they do not like the virtual learning for future studies. The students were doing open book papers so that's why they taken the virtual learning environment as a lenient way that's why their GPA was increased in the VLE semester i.e. the Spring 2020.

4.4 Results of Prediction of Academic Record of Students

The final marks of the Fall 2020 semester were predicted to check the performance of the students in the hybrid semester i.e., half semester was online and half was on campus. It was because of the government policies regarding the prevention of the COVID-19 in the ABC university. The results are shown here.

4.4.1 Fall 2019 as Training as Well as Test Model

Fall 2019 was used as training as well as test model itself on the WEKE tool. The attributes of Fall 2019 were two quizzes, two assignments and Midterm marks and the response variable was final marks, and the total number of instances was 796. The model used was linear regression and 10 cross validation was used. The root mean square was 7.5868 as shown in figure 4.11.

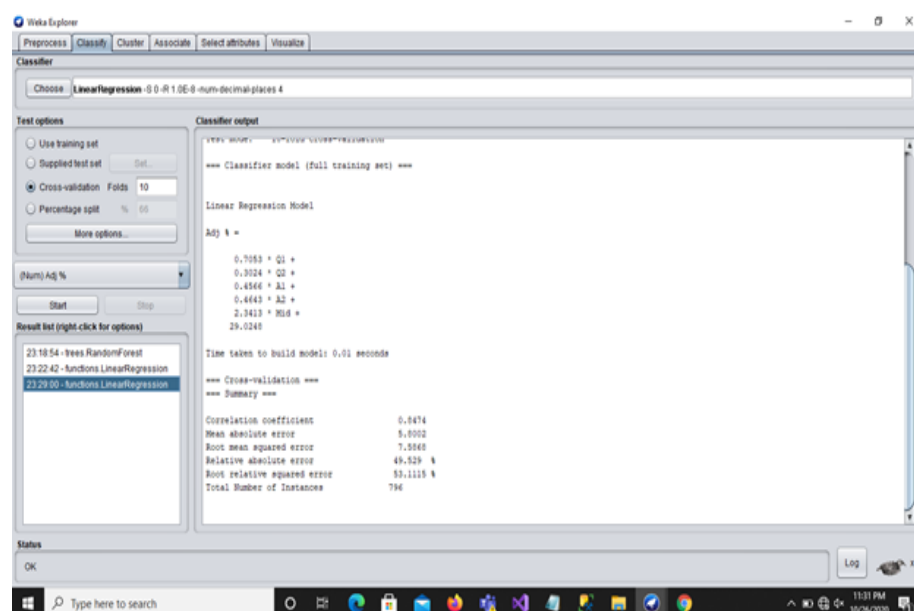


FIGURE 4.11: Fall 2019 as Training as Well as Test Model

4.4.2 Fall 2019 as Training Model and Spring 2020 as Test Data

In the prediction, there were 2 different scenarios, in the first scenario the best 2 quizzes and 2 assignments were selected and in the second scenario best 4 quizzes, 4 assignments were selected. For the prediction of the final results linear regression model was applied and the results are shown here.

4.4.3 Best 2 Quizzes and Assignments Selected for the Prediction of Results

Different attributes were selected for the prediction of the final marks. Best two quizzes and best two assignments were selected. The final marks were considered as response variable. The Fall 2019 semester was considered as training model and the Spring 2020 semester was considered as test model. The value Score of LinReg was 0.74 and the value of coefficient b1 were [0.70, 0.30, 0.45, 0.46, 2.34] and the value of b0 29.02. The first best predicted result was of the subject “Computer organization and assembly language Lab” and the value of its root mean square was 0.69 and the best second predicted result was of the subject “Data Structure” and the value of its root mean square was 0.60. The worst predicted result was of the subject “Linear Algebra” and the value of its root mean square was 0.11. The value of the root mean square can be negative for example in the subject “Compiler Construction” the value of root mean square was -0.14 [67].

TABLE 4.10: Values of Root Mean Square of Different Subjects

Sr.	Subject Name	R-Sqrd
1	Data Structures	0.60
2	Introduction to Database Systems	0.47
3	Introduction to Database Systems	0.22
4	Introduction to Programming	0.56
5	Object Oriented Programming	0.46
6	Linear Algebra	0.11

TABLE 4.10: Values of Root Mean Square of Different Subjects

Sr.	Subject Name	R-Sqrd
7	Compiler Construction	-0.14
8	Discrete Structures	0.614
9	English I	0.10
10	Object Oriented Programming	0.26
11	CS Software Engineering I	0.51
12	Software Engineering I	0.28
13	Computer Org. & Assembly Language Lab	0.69
14	Design and Analysis of Algorithms	-0.20
15	Artificial Intelligence	0.53

4.4.4 Best 4 Quizzes and Assignments Selected for the Prediction of Results

Different attributes were selected for the prediction of the final marks. Best four quizzes and best four assignments were selected. The final marks were considered as response variable. The Fall 2019 semester was considered as training model and the Spring 2020 semester was considered as test model. The value Score of LinReg was 0.56 and the value of coefficient b1 were [-0.01 , 0.09, -0.03, 0.12, 0.93] b0 -1.47. The first best predicted result was of the subject “Data Structure” and the value of its root mean square was 0.68 and the best second predicted result was of the subject “Linear Algebra” and the value of its root mean square was 0.64. The worst predicted result was of the subject “Introduction to Database Systems” and the value of its root mean square was 0.11. The value of the root mean square can be negative for example in the subject “Introduction to Programming” the value of root mean square was -0.47 [67].

TABLE 4.11: Root Mean Square Values of Different Subjects.

Sr.	Subject Name	R-Sqrd
1	Data Structures	0.68

TABLE 4.11: Root Mean Square Values of Different Subjects.

Sr.	Subject Name	R-Sqrd
2	Introduction to Database Systems s1	0.35
3	Introduction to Database Systems s2	0.01
4	Introduction to Programming	-0.47
5	Object Oriented Programming	0.76
6	Linear Algebra	0.64
7	Compiler Construction	-4.83
8	Discrete Structures	0.53
9	English I	-0.56
10	Object Oriented Programming	0.38
11	CS Software Engineering I	0.23
12	Software Engineering I	0.27
13	Computer Org. & Assembly Language Lab	0.90
14	Design and Analysis of Algorithms	-0.11
15	Artificial Intelligence	-2.22

4.4.5 Prediction of Unknown Final Marks (Fall 19 as Training Model and Fall 2020 as Test Model)

Fall 2019 semester was considered as training model and the Fall 2020 semester was considered as the test model. The attributes were two quizzes and two assignments and Midterm marks. The response variable was the final marks. The Linear regression model was applied on the training model for the prediction of the final marks. The response variable was the final marks. The Linear regression model was applied on the training model for the prediction of the final marks. The value of root mean square was 0.59. The value of root mean square was 0.59. The values of the co-efficient b_1 were [0.20, 0.14, 0.35, -0.04, 1.33] and the value of b_0 was 2.20. The data of final marks predicted of different subjects are saved in the form of Excel sheet. Fall 2019 semester was considered as training model and the Fall 2020 semester was considered as the test model.

4.4.6 Prediction of Unknown Final Marks (Spring 2020 as Training Model and fall 2020 as Test Model)

Spring 2020 semester was considered as training model and the Fall 2020 semester was considered as the test model. The attributes were two quizzes and two assignments and Midterm marks. The response variable was the final marks. The attributes were two quizzes and two assignments and Midterm marks. The Linear regression model was applied on the training model for the prediction of the final marks. The value of root mean square was 0.25. The values of the co-efficient b1 were [0.90, 0.13, 0.01, -0.01, 0.70] and the value of b0 was 6.24. The data of final marks predicted of different subjects are saved in the form of Excel sheet.

4.4.6.1 Final Words

Following are findings of this study:

- VLE is an unavoidable option in the wake of current pandemic
- Institutions, faculty members and students faced problems in the initial phase of VLE
- Infrastructural support plays a major role in the success of VLE, and the situation in Pakistan is not bad
- Certain topics in different subjects were found difficult by the students. Teachers should pay more attention while teaching those subjects
- Students are not yet fully convinced of VLE and prefer to study in the traditional environment
- Exam systems in VLE needs to be improved as the tendency of using unfair means has been found
- Proper training on VLE platform can result better outcomes for both students and teachers

Chapter 5

Conclusion and Future Work

In this chapter the research which was done and discussed in the previous four chapters is concluded. And this chapter also includes the future perspectives of this research that on which factors there is a need to do more research in future.

5.1 Conclusion

COVID-19 pandemic has severely affected every field of life including health, global economy, social conditions and education all over the world. By doing this research, it is clear that COVID-19 has negatively impacted the education system of Pakistan because the traditional education system suddenly changed to the virtual learning environment and initially it was difficult for the students to adjust with the online system. There are numbers of areas in Pakistan where is no proper access to the internet, electricity and multiple problems are there. So during this pandemic, education has become a big challenge for the people belonging to those areas. There were multiple problems faced by the students during online classes and those problems were directly associated with their understanding of the lectures and the students were uncomfortable with the virtual learning environment. The students attended the online classes by using multiple electronic devices like mobile phones, PCs and laptops and most of them are uncomfortable with these electronic devices so that was also a big issue for them.

The other thing observed in this research was that the students do not want to study in the virtual learning environment in future but their GPA was improved as compared to the other traditional education semesters, because they were taking online exams so the leniency given to them made their GPA higher but they lack technical skills because of the online education system. The prediction of the final marks showed that the prediction of marks is very important step for the improvement of the student's academic performances because if the teachers come to know that some students are weak in a particular course so they can take precautionary measures for those students by giving them more time and attention in studies and also by giving them confidence that the students can perform more better.

From the research it was concluded that during this pandemic situations, the VLE was not that much effective because of the poor infrastructural or demographic support to VLE in Pakistan and also the mindsets of the students and faculty members were not accepting the VLE at once. The VLE could be made effective for future by giving training to the teachers and students on different positive aspects of VLE so that it could be made applicable in the post pandemic era to save the time of the students. Because in the VLE, the students do not need to cover long distances for coming to the universities or other educational institutes and they can easily attend the classes at their homes.

5.2 Future Work

This study collected data from one department of one university. In order to reach more concrete findings, data should be collected from multiple universities. Moreover, the impact of VLE should also be studied with respect to faculty.

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