Effectiveness of Virtual Laboratories in Terms of Learning Environment

By:

Md: Ashikur Zaman
ID: 213-25-070

This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering.

Supervised By

Dr. Sheak Rashed Haider Noori
Associate professor & Associate Head
Department of CSE Daffodil
International University

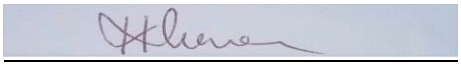
DAFFODIL INTERNATIONAL UNIVERSITY
DHAKA, BANGLADESH
21 September, 2022

APPROVAL

This thesis titled **"Effectiveness of Virtual Laboratories in Terms of Learning Environment",** submitted by Md. Ashikur Zaman, ID: 213-25-070 to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of M.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 21-09- 2022.

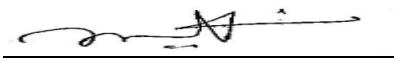
BOARD OF EXAMINERS

Dr. S M Aminul Haque, PhD **Chairman**
Associate Professor & Associate Head
Department of CSE
Faculty of Science & Information Technology
Daffodil International University



Ms. Most. Hasna Hena **Internal Examiner**
Assistant Professor
Department of CSE
Faculty of Science & Information Technology
Daffodil International University

Mr. Md. Abbas Ali Khan **Internal Examiner**
Assistant Professor
Department of CSE
Faculty of Science & Information Technology
Daffodil International University



Dr. Mohammad Shorif Uddin, PhD **External Examiner**
Professor
Department of CSE
Jahangirnagar University

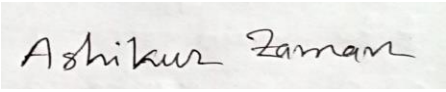
DECLARATION

We hereby declare that, this thesis has been done by us under the supervision of **DR. Sheak Rashed Haider Noori, Associate Professor & Associate Head, Department of CSE** Daffodil International University. We also declare that neither this thesis not any part of this project has been submitted elsewhere for award of any degree or diploma.

Supervised by:

Dr. Sheak Rashed Haider Noori
Associate professor & Associate Head
Department of CSE
Daffodil International University

Submitted by:



MD. Ashikur Zaman
ID: 213-25-070
Department of CSE
Daffodil International University

ACKNOWLEDGEMENT

First, we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the final year project successfully.

We really grateful and wish our profound our indebtedness to **Dr. Sheak Rashed Haider Noori, Associate professor & Associate Head**, Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of "*Effectiveness of virtual laboratories in terms of learning environment"* to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts and correcting them at all stage have made it possible to complete this project.

We would like to express our heartiest gratitude to the Almighty Allah and Head**,** Department of CSE, for his kind help to finish my project and also to other faculty member and the staff of CSE department of Daffodil International University.

We would like to thank our entire course mate in Daffodil International University, who took part in this discuss while completing the course work.

Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

As our society becomes increasingly technological, research suggests that students, need to benefit from technology-rich learning environments. In an effort both to allow students laboratory experiences that would not otherwise be possible in educational institute settings and to augment the integration of technology within science classrooms, virtual laboratories can be used to simulate real laboratories and encourage students to engage in scientific inquiry. This study investigated the effectiveness of such virtual laboratories in terms of students' perceptions of the learning environment, attitudes towards science, and achievement. Classes of students who utilized virtual laboratories were compared with classes of students who did not. And there is no opportunity for every student to doing experiment physically in the classrooms.

Data were obtained by administering the Laboratory Assessment in Genetics (LAG) containing selected scales from the Technology-Rich Outcomes-Focused Learning Environment Inventory the Science Laboratory Environment Inventory, and the Test of Science-Related Attitudes as well as some achievement items from previously validated science examinations. Quantitative data were complemented by qualitative data from interviews with students and teachers. Data analysis supported the LAG's factorial validity, internal consistency reliability, discriminant validity, and ability to differentiate between the perceptions of students in different classrooms. All six learning environment scales correlated significantly and positively with students' attitudes and some of those scales also correlated significantly with students' achievement. Most learning environment scales were also found to be independent predictors of attitudes.

TABLE OF CONTENTS

CHAPTER

LIST OF FIGURES

FIGURES **PAGE NO**

LIST OF TABLES

TABLES **PAGE NO**

CHAPTER 1

Introduction

1.1 Introduction

Students need to a strong basis in the science, mathematics and other subject for the doing competition globally. In this modern era your all work need to be competitive globally. For this, science classes day by day being the more competitive and innovative. For that, virtual laboratories is a very impactful invention for the education system. With this “virtual laboratories” study become more easier than the previous. In this system you have no need to go to the class room physically, you can finish your all lab experiment from anywhere, for that you can save your time, in this type laboratories you have no need any costly equipment, you can get available necessary equipment from the internet, by this you can save your money and your institute also save their money. Here, you have no time barrier. You can finish your work in your own time. And the most importantly, in the virtual laboratories there is no chance to being injured. It’s not harmful anymore. Is you will be committed any type of mis-communicate with your lab items or getting mixed your electronic wire in the electronic lab classes then it will be a no problem. There will be no problem.

From the school level to university level, per students spend approximately 20,000 hours in the class room. This tradition will break with the virtual laboratories. Student can joining their class from home or from anywhere. In this modern life in every phase of working level we need to focus on the international level. If we doing our classes in the VL than we can aware of the world education system. We can teach from the international teacher and into the international environment. With this every student can achieve a good level of experience. Which can help them in their future life. When they will entered the job market they will be benefited. So that nowadays virtual laboratories are considered as a great invention of the modern education system. Specially after the covid-19 situation it’s importance is going very high.

1.2 Motivation

We know, next world will be the Virtual Reality (VR) world. Already we are very depending on the social media and the internet base life style. After the pandemic it's increasing day by day. After the pandemic we solve a lot of works from our home, which we were done before the pandemic from the out side of the home. But, now times are changing rapidly so that we need to changing our life style with the time. That's why I think I should concern about the next world's technology.

And I also have an intention to go to the teaching profession. So, I should concern about the system of the upcoming education system. So, I think it will be very helpful for me.
So, after all I think it can be a good idea to do something interesting and innovative. Then I starting to learn about the idea. After a lot of learning I finally decided to do something with this innovative idea.

1.3 Relation of the study

Virtual Reality (VR) is the new technology of the next world. So, it is very important to concern and connect to the virtual lab for the better future of the science student. Specially, country like Bangladesh, there is no available facilities in lab, for every student because of the cost and the lack of lab environments, experience teachers etc. So, Here is the only solution for this problem is go to the virtual laboratories, there we can getting the international environment with the all facilities for the every student.

1.4 Research Questions

After starting the research work, in the very first we need to divided the hole research into some questions. Here we divided the research topics into the four parts. Here it is:

Question 1:

What about the virtual laboratories quality in terms of learning environment, valid, as per of the student expectation and the achievement?

Question 2:

What is the deference between the virtual laboratories and the non-virtual laboratories in term of the environment and achievement?

Question 3:

What about the effectiveness of virtual classes in term of the student's perceptions, learning environment, attitudes and the achievement?

Question 4:

What about the effectiveness of virtual laboratories in terms of gender discrimination?

1.5 Expected Outcomes

This Virtual Reality (VR) thesis is bringing some ethical research results about the study of about the virtual laboratories. That's helps us to find some ways for presenting the virtual laboratories in some easy way.

1.6 Project Management and Finance

The whole project's planning, writing by me. For doing this job a lot of people help me a lot specially my thesis advisor. So, after all thanks to all, for give me the support and motivate for doing a great job. And, Finally thanks to the almighty Allah.

1.7 Report Layout

This thesis report has been divided into 6 chapters which documented the concepts and solutions behind the effectiveness of the virtual laboratories in terms of learning environments. Here is the introduction of these 6 chapter:

Chapter 1: This chapter has introduced the thesis in terms of its context, motivations and objectives.

Chapter 2: Discusses about discussed background of this project and related works that were conducted by others. Then we analyzed the problem that were faced and scope of the problem that were not considered in their solution.

Chapter 3: In this chapter discuss about the methodology of the research's, the procedure of collections of the data, implementation requirements, applied mechanism and the statistical analysis of this thesis. This chapter will be the considered as the main part of this report.

Chapter 4: Here we discuss about the set up of the experiment, the results of the experiment and It's analysis and the further discussion about the thesis topics the effectiveness of the virtual laboratories in terms of the learning environments.

Chapter 5: Here we discuss about Impact on Society, Environment, Sustainability and the ethical aspects of the thesis**.**

Chapter 6: And finally, In the last chapter we discuss about the project's summary, conclusion and further scope.

CHAPTER 2

Background Study

2.1 Terminologies

In this section we are discuss about background study of this virtual laboratories topics. Here our main aim is to details investigate about the effectiveness of the virtual laboratories. We starting study form the very first to the bottom or the latest update of the virtual laboratories. We try to figure out about the perception of the student interest, how they receive it in their education life, how they react when they are in the VL classes. What is the perception about the male and female student's in terms of VL classes. What about the attitude for science classes in terms of the male and female student. How they both get the teacher support in the VL classes and the non VL classes. What they prefer the most. And the most importantly what about the achievement from the virtual laboratories classes. Is it fully replaceable from the traditional classes? Like this type of many questions we need to find the answers for the fully understood the condition of the virtual laboratories achievement and the effectiveness in terms of the students perception. We need to find the all data for the standing the one conclusion. And we need to figure out about the cost of virtual laboratories equipment. Is this cost more then, the non-virtual laboratories classes? What will be the more benefited for the students and the institution in terms of cost? After collecting the all data we need to starting the research main work. Then it will be the more-clear image for the researcher. And we will get the better results from the research.

This part of the reviews literature concerning various aspects of the field of learning environments in terms of virtual laboratories. First of all it's provides the historical background of the development. And then instruments used to assess the learning environment are explored. And then lastly the reviews how learning environment scales have been applied in research in classrooms.

2.2 Related Works

Educational scholars who have examined the factors that contribute to the academic success of African Americans have focused on primarily two schools of thought (Bush & Bush, 2010). The first school of thought analyzes individual characteristics and the second focuses on pre-college indicators, known as cognitive and non-cognitive variables, respectively (Bush & Bush, 2010). Cognitive variables are factors such as high school grade point average, level of math completed, test scores, and placement scores (Bush & Bush, 2010)., defined cognitive variables, "as those variables that objectively measure intellectual ability and are exhibited by some numerical score, rank or range". Johnson defines non-cognitive variables "as affective, psychosocial constructs, subjective in nature that describe the feeling, perceptions, and/or attitudes".

2.3 Scope of the Problem & Comparative Analysis:

In the traditional education system for laboratories is running for a very long time. It is very good learning process, in the traditional education system teachers and students can be the very supportive and enjoyment. But in the traditional classes in the laboratories there are some problems for the lab equipment and the other facilities and the time managements and very importantly the risk factor. After the internet available, policy makers are finding a great option "virtual laboratories". Firstly, in some develop country institute starting the virtual lab in the risky experiments, then after the covid-19 pandemic, when the hold world is going through the very critical time, then every institute are going to the on-line education. In the on-line education virtual laboratories is the only solution. And day by day students are adopting this new education system. There are lot of benefit in the virtual laboratories. First of all, you don't need to come out from home for the school, you can learn from home, there is no big amount of cost without internet. This is fully risk-free laboratories, here you can customize your time, how you want. There is a lot of time to experiment more and more time.

In this types virtual laboratories, we can solve a lot of problems, we can doing our previous lab classes and the next classes. It can be more benefited for the students. And if we talk about the teacher support, here we can get the more teacher help. Teacher get more time to explain the problems and it will be the head to head. And it is a very enjoyable class environment for the both male and the female students. This type of class are less risky then the practical classes. There is no chance for the any types of human injury. Virtual laboratories are very safe for the female students. There is no gender issue. In the virtual classes student get the international environment for the learning, they can know about the international students work flows, how the learn, what they learn. Every student from the any country in the world can sharing their ideas and the learning subjects. With this type of learning, students can prepare them for the international market or the any international competition. This will be the very good for the students in the long run in terms of the education.

2.4 Challenges

In every phase of life there are challenges but we I overcome the challenges to make something good. The challenges I have faced are given below:

It was one of the biggest problems for us that we spent a huge time to ensure the trusted sites or sources for collecting data.

As some related papers have already been made, we tried to find some bugs and discuss to fix all of them.

To doing the project research some question comes by the discussing the papers:

1. Is the virtual education system fully replace the traditional system?

2. How much the students be benefited from this system?

These questions are worth investigating because their answer would help us determine and realize the scope of this thesis.

CHAPTER 3

Research Methodology

3.1 Research subject and Instrumentation

In this chapter will discuss about the research methodology of the virtual laboratories in terms of the effectiveness and the learning environments. In this chapter we discuss how virtual laboratories works and how it's helps the students for their experiment solving. In the virtual laboratories genetic problems solving is giving very great feedback. We know in our institute there is no available equipment for the doing all types of the experiment. So here virtual laboratories provide a very great impact. With the virtual laboratories all students get the opportunity to do the lab experiment. However, qualitative data, through semi-structured interviews, were added to embellish the quantitative results. This chapter describes and justifies the methodological aspects of this study in terms of the research questions guiding the methods, the sample selection, the materials use including assessment instruments and other resources, the procedures followed, data collection, entry, and analysis and limitations of the study.

For the research of the virtual laboratories we need to discuss about the experts, we need to talk with the developers, we need the talk with the teachers, we need the talk with the students male and female both individually. After discussing with the all parties we need to pointed the all possible points, then we need the gather the all data what we pointed. After collecting the all data we need to parted the all data and staring the analysis to understand the hole scenario about the virtual laboratories. And we need also collect the data from the virtual lab classes and then need to investigate the all data. Then we need the compromise the both data and calculate the all data. When a total of six students followed through on their initial expression of interest to be interviewed, telephone or Skype appointments were set up for this purpose. Face-to-face interviews were not possible because the interviewer and interviewees were not located in the same geographic area. Informed consent was obtained from students and their parents.

3.2 Data Collection procedure

For the collecting the data we need to go through the schools and the all type of class where practical classes are doing. Then we need to talk to the teacher, we need talk to the students, specially from the female students, what they think about the VL and non VL classes. Where they feel more-safe, where they can learn more, which environment they prefer the most. We need to talk with the institute, hoc they react about the VL classes. How it's provide impact in their institute. How it reduce their cost, and how they can be benefitted from that. We need to collect both the qualitative and quantitative data. We need to collect the all qualitative and quantitative data from the both traditional lab classes and the virtual lab classes. We need to collect the various types of data from the both classes. And we also need to takes helps from the many international organization who works with the this types of data related works. Quantitative data were collected using scales from the four instruments included in the Laboratory Assessment in Genetics, namely, the SLEI, TROFLEI, TOSRA, and achievement examinations. The LAG was administered to 322 students in 21 classes in six different US schools in the states of Massachusetts, New York, Pennsylvania, and Virginia. Questionnaires were either mailed to the teachers requesting paper versions, or provided as an online link to teachers who requested the electronic versions. In both cases, the researcher provided to the teacher for each class specific codes, which identified the teacher and treatment condition without revealing the names of the schools, teachers, or students.

3.3 Statistical Analysis

Here discuss about the statistical observation of the effectiveness of the virtual laboratories in terms of learning environment.

Question 1: What about the virtual laboratories quality in terms of learning environment, valid, as per of the student expectation and the achievement?

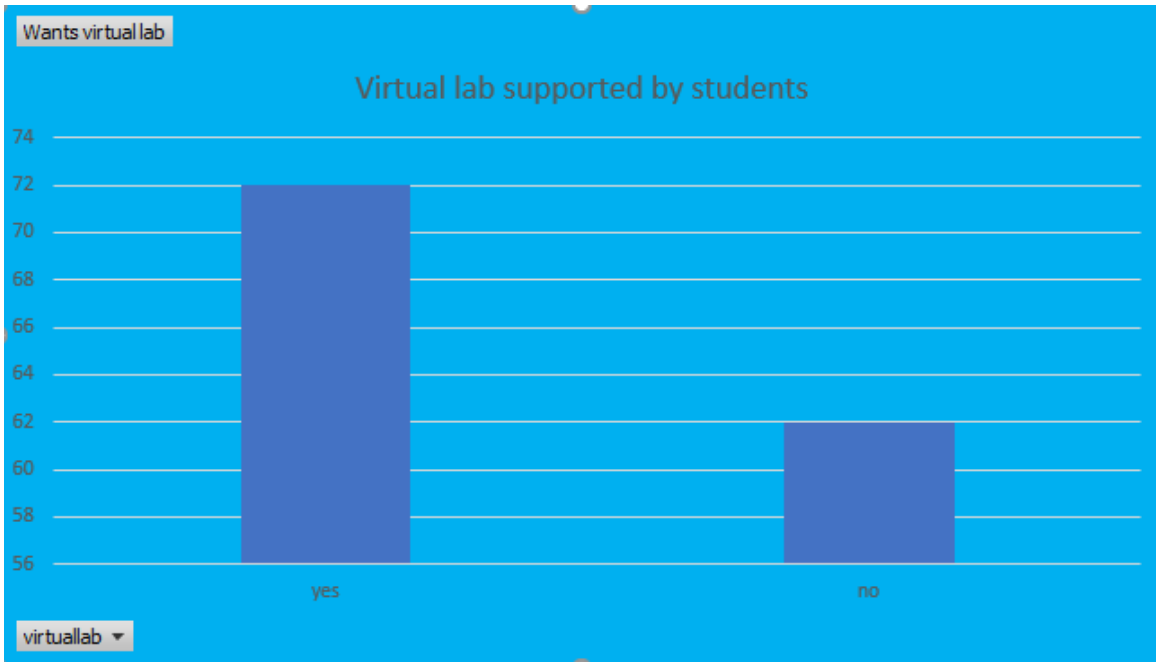


Figure 3.3.1 Virtual lab supported by the students

Regarding the first research question, the questionnaire administered to a sample of American biology students had to be checked to ensure that it would be a valid and reliable instrument with which to gather data for this population. To accomplish this, the scales from the SLEI, TROFLEI, and TOSRA were subjected to factor analysis to check the questionnaire's structure. Principal axis factoring with varimax rotation was employed because of its ability to organize components of the questionnaire by common dimensions.

Question 2: What is the deference between the virtual laboratories and the non-virtual laboratories in term of the environment and achievement?

For the second research aim regarding associations between perceived classroom learning environment and the student outcomes of achievement in and attitudes towards science, simple correlation and multiple regression analyses were used with the individual student as the unit of analysis. Simple correlation was used to describe the bivariate relationship between each student outcome (attitude or achievement) with each learning environment scale. Multiple regression analysis was used to investigate the

combined influence of the whole set of learning environment scales on each student outcome, with the standard regression coefficient (β) being used to indicate the contribution of each learning environment scale to the variance in student attitudes or achievement when other learning environment scales were mutually controlled. The multiple correlation represented the multivariate association between student attitudes or achievement and the set of all learning environment scales. The strength of associations was measured by the coefficient of multiple determination.

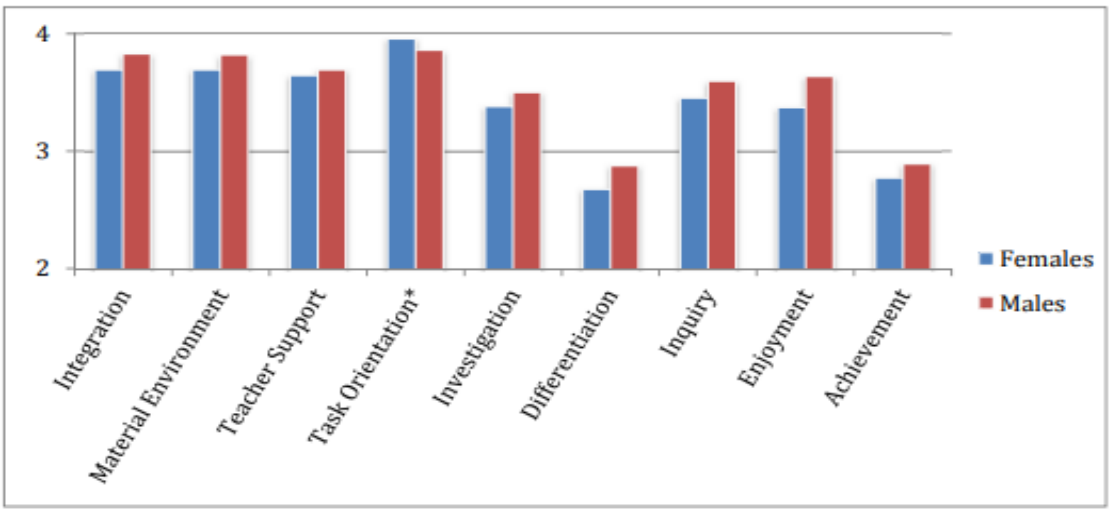


Figure 3.3.2 Profile of Means for Different Sexes as Measured by Laboratory Assessment in Genetics

Questions 3 and 4: What about the effectiveness of virtual classes in term of the student's perceptions, learning environment, attitudes and the achievement? What about the effectiveness of virtual laboratories in terms of gender discrimination?

Students perception about the learning environment in the VL and non VL classes are different one from the another. As we shown in the figure, when we talk about the learning environment of the classes then we can see the for the male students virtual laboratories are giving the more impact than the traditional or physical lab classes. Male students reported that, they are getting more good environment then the traditional lab, but when we take about the female students, they think for their traditional class was more helpful in terms of the learning environment.

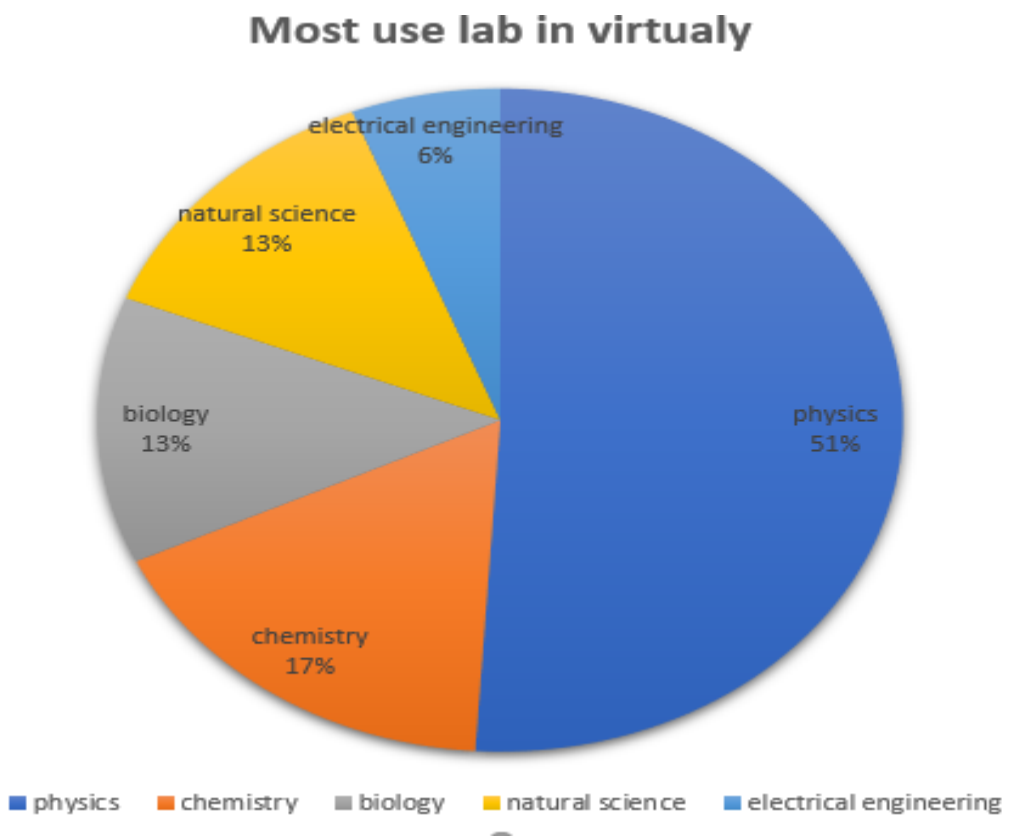


Figure 3.3.3 Most usable virtual lab by the subject

And reports shown that the virtual lab classes are more effective then the traditional or the physical lab classes. And virtual lab classes achievement are better then the physical classes. Female students claims that the physical classes are better for the teacher supportive then the virtual lab classes but the male students reported that the virtual classes are the more supportive then the physical classes in term of the teachers support. And without this point al lot of points have hidden. Where we can see the virtual lab classes are the more safe for the students specially for the male students. And if we talk about the situation of the after pandemic, then we can shown that every students and teachers want to do classes in the online. So now, virtual classes are more good about the doing classes or In terms of the learning environments and the situation where are we from. And if we want to add some current news, government also wanted to cut short the schooling for the health issues, for the lack of the power supply, for the uncertainty of the economic situation of the government and current situation of the world economy. So we can consider the virtual laboratories as a perfect solution for the lab works of the education system. And it will help the students very much in their lab classes.

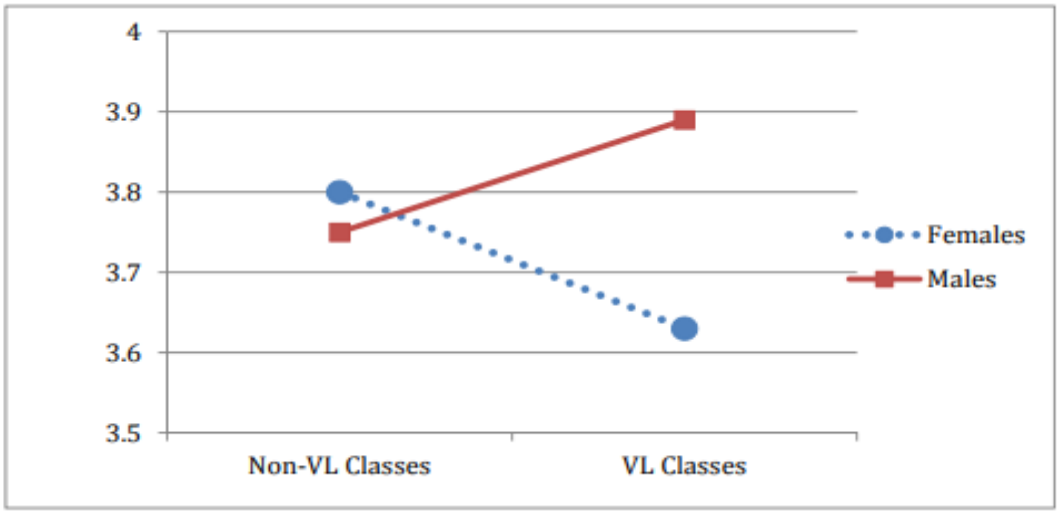


Figure 3.3.4 Effectiveness of Virtual Laboratories for Females and Males for Scale of Teacher Support

3.4 Proposed Methodology

The research methodology of the effectiveness of virtual laboratories should be very user friendly, effective, smooth and easy to use. When developer develop the software for the virtual laboratories then, need to concern about the effective ness of the system and the smooth user access ability for the use. With this type of the virtual laboratories every student's get the opportunity to do the all experiment and they can do in the several times and the large amount of time. And specially in the pandemic time and the after of the pandemic time we are always concern about our health, that's why we actually furious about come out from home to do anything. In this situation virtually works is very helpful for us. And if we talk about school, college or university, it's always be populated. So, if we have an opportunity to avoid this type of crowed, why not we accept that. So, by the all aspects virtual laboratories is very benefited for us. And we should encourage all the students to doing their lab works in the virtually.

CHAPTER 4

Experimental Results & Discussion

4.1 Experimental Setup

The experimental setup for the getting results of the virtual laboratories in terms of the effectiveness of the learning environment will discuss in this chapter. After the experiment of the topics we shown the results of our research questions and then we can discuss about the results. Then we can point some solution and the some of the ways what is the best practice for the students. We can learn about the solution and the all visual parts of the virtual laboratories and the physical or traditional lab claases. This chapter reports and interprets the findings of this study. Each of the research questions is addressed by analyzing data and then determining whether the hypothesis for that question is supported. As described in Chapter 3, the majority of this study was based on quantitative data collected using the Laboratory Assessment in Genetics (LAG). Qualitative data stemming from semi-structured interviews were used in an attempt to fill gaps in the quantitative data, and to provide a more holistic view of the effectiveness of virtual laboratories. This chapter first presents results for validation of the instrument used to collect quantitative data, the LAG. The LAG contains 74 items in nine scales adapted from several other validated questionnaires: the Science Laboratory Environment Inventory (SLEI), the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI), the Test of Science-Related Attitudes (TOSRA), and achievement items from state standardized examinations in Biology.

4:2 Experimental Results and Analysis

Here we discuss about the experimental results of the virtual laboratories effectiveness in terms of the learning environment and the traditional lab classes and then we will analysis the results what we get from the experiments:

Question 1: What about the virtual laboratories quality in terms of learning environment, valid, as per of the student expectation and the achievement?

This section reports the factor structure, internal consistency reliability, and discriminant validity for earning environment scales and attitude scales. Focuses on the ability of the learning environment scales to differentiate between classrooms. Validation of the achievement section of the LAG, comprising the last 10 items, is also reported. Factor Structure of Learning Environment and Attitude Scales Because items were modified from the original scales from which they were adapted, the internal structure of the various learning environment and attitude scales was examined to ensure validity.

We starting study form the very first to the bottom or the latest update of the virtual laboratories. We try to figure out about the perception of the student interest, how they receive it in their education life, how they react when they are in the VL classes. What is the perception about the male and female student's in terms of VL classes. What about the attitude for science classes in terms of the male and female student. How they both get the teacher support in the VL classes and the non VL classes. What they prefer the most. And the most importantly what about the achievement from the virtual laboratories classes. Is it fully replaceable from the traditional classes? Like this type of many questions we need to find the answers for the fully understood the condition of the virtual laboratories achievement and the effectiveness in terms of the students perception. We need to find the all data for the standing the one conclusion.

Question 2: What is the deference between the virtual laboratories and the non-virtual laboratories in term of the environment and achievement?

In the VL classes students are more experimental, more actives, that's helps they to know more. In the non VL classes students have mixed reaction for the scale of learning. All equipment available in the VL classes for the each and every student. Sometimes it's can't possible to arrange technically sound equipment for the all students. Teacher support is all time very good. Whenever student want help from them teachers are very helpful. Teachers are also helpful but there is a lack of understanding and explaining of

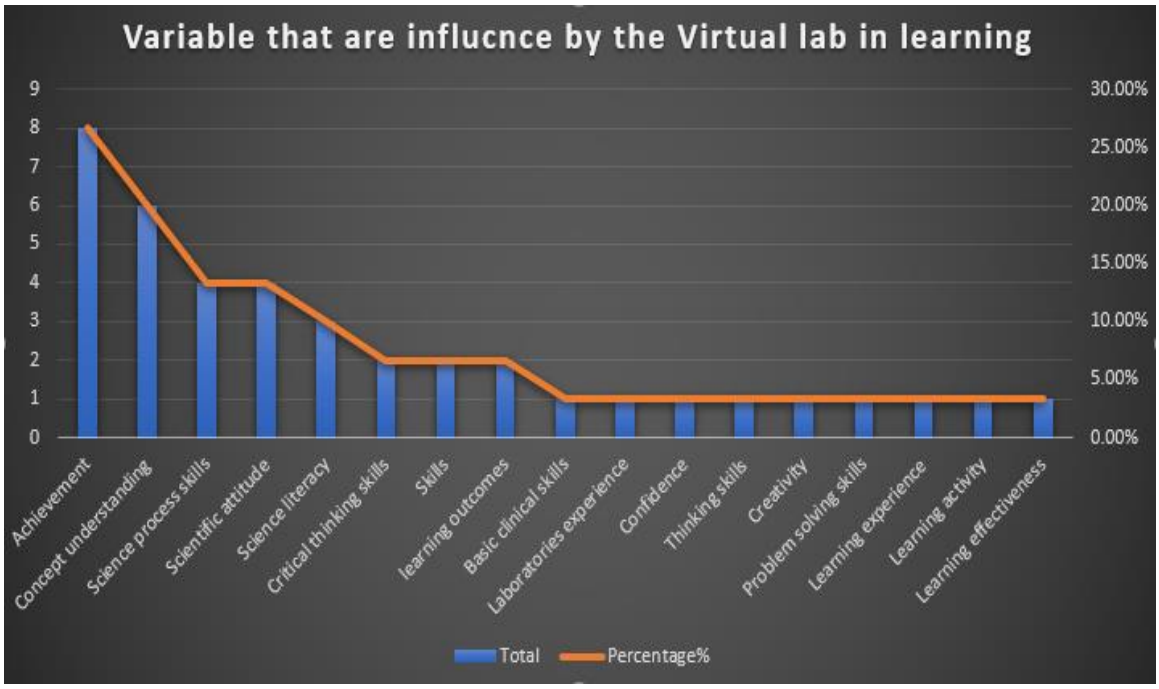


Figure 4.2.1: Variable that are influence by the virtual lab in learning

problems. Student considered the VL classes are more enjoyable. And they work alone and also making fun in the work time. In the non VL classes student not feeling enjoyable, they reported teachers are boring during the class time. Students can learn from experiments in the international level. So that, their achievement is so good in the VL classes. Students finished their work under the tight schedule. So that, they finish their learning and finally their achievement from the classes are good.

In this system you have no need to go to the class room physically, you can finish your all lab experiment from anywhere, for that you can save your time, in this type laboratories you have no need any costly equipment, you can get available necessary equipment from the internet, by this you can save your money and your institute also save their money. Here, you have no time barrier. You can finish your work in your own time. And the most importantly, in the virtual laboratories there is no chance to being injured. It's not harmful anymore.

Question 3: What about the effectiveness of virtual classes in term of the student's perceptions, learning environment, attitudes and the achievement?

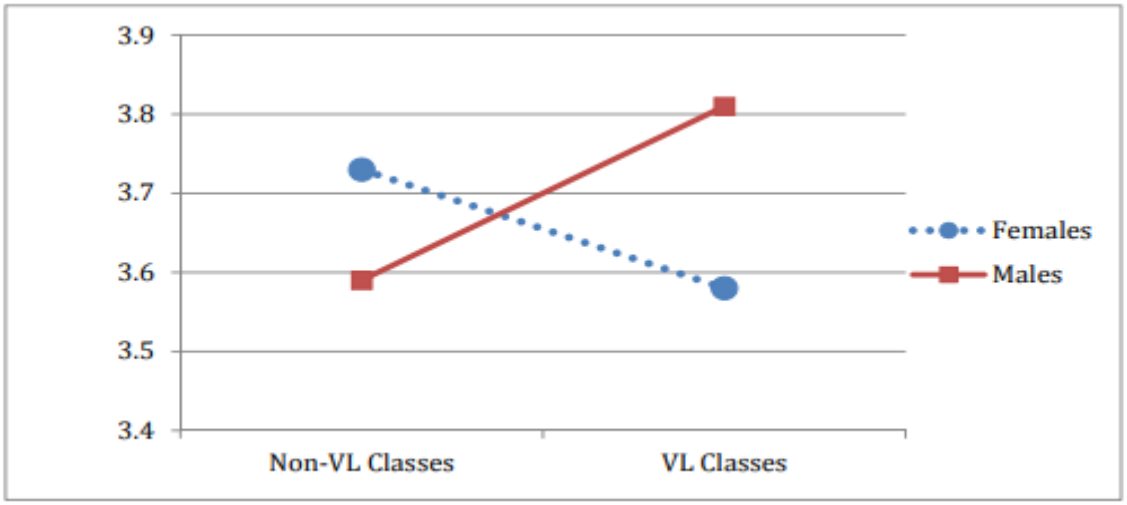


Figure 4.2.2 Differential Effectiveness of Virtual Laboratories for Females and Males for Scale of Inquiry

Is you will be committed any type of mis-communicate with your lab items or getting mixed your electronic wire in the electronic lab classes then it will be a no problem. There will be no problem.

Question 4: What about the effectiveness of virtual laboratories in terms of gender discrimination?

Virtual laboratories classes are very useful for the female students. In this type of classes they don't to come out from home, so that they don't need to travel, it's very helpful for their security. Virtual laboratories is the considered very useful teaching method. Where students takes a lot of time to learn with the various source. Here we discuss about the gender discrimination about the effectiveness of the Virtual laboratories and the learning environment of the Virtual laboratories.

Table 4.1 Student Interview for Sex Differences for Learning Environment.

Learning Environment	Perceived Sex Differences
Integration	There is no differences between the males & females students.
Material Environment	No issues found for the material environment in the VL classes.
Teacher Support	Female students support non VL classes then VL classes, they think non VL classes are more supportive for the basis of teachers support. Males students likes both VL & non VL classes.
Task Orientation	Males sometime remain works unfinished but females do it accordingly in any stage.
Investigation	There is no differences between the males and females to it.
Enjoyment (Attitude)	Males like to do works as a team, they think it's more enjoyable. But for the female students, VL & non VL all are same.
Achievement	Achievement for the males and females are in the same levels. Both are doing good enough in the report card.

4.3 Discussion

In this section discuss about the summary of the hole research. Here we showing the difference between the virtual laboratories classes and the traditional lab classes in terms of the integration, material environment, teacher support, task orientation, investigation, enjoyment and the achievement of this two sides.

Table 4.2 Student Interview for Learning Environment.

Learning Environment	Students in VL classes	Students in non-VL classes
Integration	In the VL classes students are more experimental, more actives, that's helps they to know more.	In the non VL classes students have mixed reaction for the scale of learning.
Material Environment	All equipment available in the VL classes for the each and every student.	Sometimes it's can't possible to arrange technically sound equipment for the all students.
Teacher Support	Teacher support is all time very good. Whenever student want help from them teachers are very helpful.	Teachers are also helpful but there is a lack of understanding and explaining of problems.

Task Orientation	Students starting and finished their work timely and get positive result.	Students starting and finished their work timely and get positive result.
Investigation	Students following the given rules by the lab instructions.	Students are served the instruction what they will do, then they are following the teachers
Enjoyment (Attitude)	Student considered the VL classes are more enjoyable. And they work alone and also making fun in the work time.	In the non VL classes student not feeling enjoyable, they reported teachers are boring during the class time.
Achievement	Students can learn from experiments in the international level. So that, their achievement is so good in the VL classes.	Students finished their work under the tight schedule. So that, they finish their learning and finally their achievement from the classes are good.

Here we discuss about teachers observation for the virtual laboratories classes and the traditional lab classes in terms of the integration, material environment, teacher support, task orientation, investigation, differentiation, enjoyment and the achievement of this two sides.

Table 4.3 Teachers' Observations for Learning Environment.

Learning Environment	**Teachers' Observations**
Integration	All teachers repotted that, they always try to maintain a combination between the theory and practical classes.
Material Environment	Some of the teachers repotted that the shortage of the devices and the slow internet providing a bad impact in the VL classes. And the genetics subject are very much into the virtual laboratories.
Teacher Support	Teachers think that the they need to more active in the non VL classes than the VL classes. In the VL classes they need to teach only the starting, but in the non VL classes need to maintain full class time.
Task Orientation	There is no difference between the VL and non VL classes in terms of the task. In the VL classes they need just motivated the students.
Investigation	There is no deference from both experiments.
Differentiation	Teachers reported that students are able to maintain their own work as per the time. So that, it becomes the students more-stronger.

Enjoyment (Attitude)	Teachers observed that students are more enjoying to doing the VL classes. But we need to aware, so that their mind not converted to the video games or so on.
Achievement	One teacher reported that her classes, regardless of the instructional method, perceived the genetic achievement items as being too easy. Another teacher observed that males were required to do more mental processing with VLs, as opposed to non-VLs, in that they simply explored and left the mental processing to their female partners.

CHAPTER 5

Impact on Society, Environment and Sustainability

5.1 Impact on Society

This project providing a good impact in our society. By this project we don't need to come out from home's. In the pandemic which is very important for us. In the pandemic and after pandemic we always try to avoid gathering. We know school, college and university area are always very populated. If we can practice our lab classes virtually, then we don't need to go out from home, by this we can protect our health. In the virtual works life we can spend our more time with family, it's makes our family bonding more strongly.

The effect of the virtual laboratories is so impactful in our society. We can considering it's as a visionary movement for the education system. Day by day it's uses increasing. Than after couple of years it's seems that it may be fully replace the traditional education system. In this super-fast digital life day by day we are converting to the online life, that's why after some years education system may be also fully converting into it. Than it's fully changing our thought about the traditional education system and society also starting to thinking about the new system.

5.2 Impact on Environment

This project has a big directly environmentally impact. It has a lot of opportunity to grow impact on our environment. We know, our country is very dirty in the town side's. Dust of electronics are through very unethically. That's why, we find in very dirty all time. We can call it the lack of management. We can fix this problem with this super excellent project the virtual laboratories. We know in the virtual laboratories we actually doing all work in virtually. We never ever used any equipment physically. That's why actually we no need a lot of lab equipment.

Generaly in the lab, if we want to doing a test on a circuit, then we need a lot of electronics wire, miter, circuit board, AC-DC supply machine and a lot of others machine in the basis of the experiment. During the experiment time a lot of equipment are not working, then we need more to replace it. And the waste equipment's are providing a very bad impact on the environment. So, if we can doing our lab experiment in virtually then it will be very benefitting for the environment.

5.3 Ethical Aspects

There are a lot of cause for use this system, by this we can experiment, calculate, manage our labs in very good sequences and with a large amount of time and a large number of times. So, we can hope that, students will be interested to use this system for the ethical aspects of this system. And we also hope that students will be very happy and profited to use this system.

To use the virtual laboratories there is a lot of ethical aspects. First of all, we cane manage our time, what we want, then we can do the experiment's a lot of time, for doing the experiment we have no need any cost, and very importantly it fully risk-free. And, also it has a lot of good impact. So, we can considering it's very use full for the students and the teachers.

5.4 Sustainability Plan

Like every software we need to upgrade this system by the time. For sustainability, the software need to updated, need to investigate the situation, look after the other system's updating and create some upgrading plan and need to it execution.

If talk about the sustainability about the system of virtual laboratories, so we need to focus about our system updating. Any time new problems are coming, than we need to work on it, we need to create new systems and we need to upgrading our systems when it need and in the basis of the users. Our all focus will be the reaction of the users, when user think that it will be the problem in some cases, then we need to focus on it, and then need to fixed it. By this procedure our system will be going to a long run. And we also

focus about the teachers demand, because for all lab experiment we need to develop the program, and for the new problem we need to develop the new set up for the experiment. First of all we should hire the experience the teacher for the test experiments, then we should launch the system. By this system it will be the sustainable for the long time.

CHAPTER 6

Conclusion and Future Scope

6.1 Summary of The Study

The thesis is going to a series of activities to develop such a complex discussion for the effectiveness of virtual laboratories in terms of learning environment. After analyzing the project's requirements and research direction, a set of objectives are established. All activities done during the discuss of this project were attempts to accomplish these objectives. Through the whole thesis, it's trying to show how the process working, the benefit of the virtual laboratories and the further study of the virtual laboratories. In the report we through some questions and figure out the answer of this issues. And finally, we discuss about the hole process about the topics the effectiveness of the virtual laboratories in terms of the learning environments. We describe about the perception of a teacher, students in the all learning environments. And I hope it is a very effective for the students, by thus they can learn more topics, it's will help them to know the what are done by the others students globally.

6.2 Conclusions

Here we discuss about the effectiveness of the virtual laboratories in terms of learning environments all points. After the pandemic increasing it's use day by day. So, now the time to takes it more likely from the institutes. Every institute need to develop their private virtual laboratories, so that the connection between teachers and the students will be very good and effective to learning. The virtual laboratories set a very unique perception of a student for his learning environment and it will be improving its use day by day. And this is the considered the next level of the education. By this education system students gets the opportunity to solve the large number of the problem or experiments and they can do that again and again. It's improving their confidence and the quality of their works. It's needs to do the system updated all time, so that the works will be the user friendly.

6.3 Implication for Further Study

Science is always updating, what we use today, tomorrow may-be it will be changed. So that, this software also needs to updating day by day. And also need to testing the software every moment. And if we try to think more visionary, we will doing our lab works in next generation world in the metaverse world. There if will feel like be more realistic and very authentic.

REFERENCE

[1] The Effects of a Virtual Laboratory and Metacognitive Scaffolding on Students' Data Modeling Competences, available at<< https://eric.ed.gov/?id=EJ1278190>> last accessed on 5-8-2022 at 7pm.

[2] The Utilization of Virtual Laboratory in Learning: A Meta-Analysis
, available at<<
https://www.researchgate.net/publication/344095973_The_Utilization_of_Virtual_Laboratory_in_Learning_A_Meta-Analysis>> last accessed on 25-7-2022 at 10pm.

[3] Virtual Laboratories- A historical review and bibliometric analysis of the past three decades, available at<< https://link.springer.com/article/10.1007/s10639-022-11058-9>> last accessed on 2-6-2022 at 5pm.

[4] Using virtual labs to enhance students thinking, available at<<
file:///C:/Users/Hp/Downloads/13_1%20(2).pdf>> last accessed on 15-5-2022 at 7pm.

[5] Students' Perceptions of Doing Virtual Science Labs in a Hybrid Charter School, available at<<https://members.aect.org/pdf/Proceedings/proceedings13/2013i/13_31.pdf>> last accessed on 9-6-2022 at 10am.

[6] Trickett, E. J., & Moos, R. H. (1973). Social environment of junior high and high school classrooms. Journal of Educational Psychology, 65, 93-102.

[7] A comparative study on real lab and simulation lab in communication engineering from students' perspectives, available at<< https://www.tandfonline.com/doi/full/10.1080/03043797.2012.755499>> last accessed on 1-7-2022 at 2pm.

[8] Student perceptions of online and in-person microbiology laboratory experiences in undergraduate medical education
, available at<< https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7006765/>> last accessed on 13-7-2022 at 4pm.

[9] Intersecting Virtual Patients and Microbiology: Fostering a culture of learning
, available at<< https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4642256/>> last accessed on 3-7-2022 at 6pm.

[10] An Evaluation of Computer-Based Instruction in Microbiology
, available at<< https://journals.asm.org/doi/full/10.1128/me.1.1.14-19.2000>> last accessed on 5-5-2022 at 7pm.

[11] ASM Biofilm Image Project1998copyright date [Online]. American Society for Microbiology, available at<< http://www.asmusa.org/edusrc/edu34.htm>> last accessed on 3-8-2022 at 11pm.

[12] Bio-Films: The Movies1998copyright date [Online] General Microbiology Course Site, Department of Microbiology, Cornell University, available at<<
http://instruct1.cit.cornell.edu/courses/biomi290/Horror/Biofilmmenu.html.>> last accessed on 20-8-2022 at 10am.

Final_Report_Ashikur_213-25-070.doc

ORIGINALITY REPORT

19%	19%	4%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	core.ac.uk Internet Source	15%
2	Submitted to Daffodil International University Student Paper	2%
3	scholar.stjohns.edu Internet Source	1%
4	dspace.daffodilvarsity.edu.bd:8080 Internet Source	1%
5	G. Sundari Pramathevan, Barry J. Fraser. "Learning environments associated with technology-based science classrooms for gifted Singaporean females", Learning Environments Research, 2019 Publication	1%
6	Céline Byukusenge, Florien Nsanganwimana, Albert Paulo Tarmo. "Effectiveness of Virtual Laboratories in Teaching and Learning Biology: A Review of Literature", International Journal of Learning, Teaching and Educational Research, 2022 Publication	<1%

Exclude quotes	On	Exclude matches	< 10 words
Exclude bibliography	On		