The Effectiveness of Virtual Labs in Higher Education Institutions of Botswana:

A Case Study of Botho University

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DECLARATION

I hereby declare that this study titled ***The Effectiveness of Virtual Labs in Higher Education Institutions of Botswana: A Case Study of Botho University*** is my work, that it has not been submitted before for any degree or examination in any other University and that all the sources I have used or quoted have been indicated and acknowledged as complete references.

RAMANDEEP KAUR

Sign: …….

Date: Tuesday, January 16, 2018.

DEDICATION

I dedicate this work to my husband Jagpreet Singh and children Tanveer Singh and Arshveer Singh for their support and encouragement.

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I would like to thank Botho University for granting me the permission to conduct this study and also to sponsor this degree.

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ABSTRACT

The purpose of the study was to examine the virtual labs implemented by Botho University for Computing program for online distance learning students. This study has evaluated the lecturers' perception on the usage of virtual labs to enrich students' learning and experience to enhance their knowledge, skills and competencies. Quantitative research method was employed with closed-end structured questionnaire to collect the data. The SPSS version 21 was used to analyze quantitative data on the role of virtual labs.

Findings of the study has shown that, besides students being faced with some challenges, virtual labs have positive impact on students' learning. Virtual labs are the future of higher education. Virtual labs help students to enhance academic performance and to gain knowledge and skills required for global job-market.

This study has recommended to provide training to students to guide for proper utilization of its components. There is a need to upgrade the internet bandwidth and incorporate virtual labs in the curriculum and make its usage mandatory.

ACRONYMS

DL – Distance Learning

VLABs – Virtual Labs

HEIs – Higher Education Institutions

BU – Botho University

ICT – Information and Communication Technology

VLE – Virtual Learning Environment

BUAN – Botswana University of Agriculture and Natural Resources

STEM – Science, Technology, Engineering and Mathematics Education

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CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

This study evaluates the effectiveness and implementation of virtual laboratories for undergraduate students in computing programs, a case of Botho University in Botswana. E-Learning has become a valuable pedagogical tool of education. With the ease to access the education in eLearning mode, demand for education is increasing on everyday basis. Higher education institutions are providing many programs, courses through e-learning. Empirical studies have proved that e-Learning education has positive impact on students' academic performance and effective way of achieving learning outcomes. Laboratories environment has great impact on leaning. It provides students experience to work in real-world based problems and equip with the skills required by today's workplace. Laboratory sessions are important for all the practical courses. Practical experience is the essential element of the education process (Alexiou, 2004). Laboratory sessions provide learners with hands-on experience and opportunity to acquire necessary skills to perform in real-world environment (Lampi, 2013; Lynch, 2016; Zhou, Xing, & Chen, 2009). *The laboratory education helps students to gain experience and skills in theory and practice of experiments with easy access to real systems with all operational characteristics* (Wolf, 2010).

Virtual lab plays very important role in HEIs with its unique features. Virtual labs help students to enhance their learning experience. Due to lack of adequate laboratory resources and technical support in developing countries, virtual labs are becoming popular and effective e-Learning tool. Virtual laboratories are cost effective. HEIs with limited budget, technical assistant and technical resources, are implementing vLabs for their students to practice laboratory experiments. The purpose of this study is to determine the effectiveness of virtual labs implemented by Botho University for the undergraduate students of computing program. This study is conducted in Botho University, situated in developing country of Botswana. This study will evaluate the experience of lecturers and students in utilizing the components of vLabs and examine if vLabs are helping lecturers and students to achieve their learning outcomes.

1.2 BACKGROUND OF THE PROBLEM

"*Education is a vehicle for national economic growth and basic right for social and individual development*", (Ministry of Education and Skills Development, 2015). Botswana education system is divided mainly into five levels, pre-primary, primary, junior secondary, senior secondary and tertiary education. Education in Botswana is free for 10 years which includes primary and junior secondary levels. Senior secondary is for two years and which is the pre-requisites for tertiary education. There are many private and public tertiary institutions in the country. Most of the students are government sponsored, education is free but not compulsory. The process of academic selectivity has reduced the entrance into the tertiary level education for higher education institutions (Ministry of Education and Skills Development, 2015). Girls and boys have same access for education, but the dropout rate is high for girl students due to early pregnancy. Other elements for high dropout rate for tertiary level learners includes family responsibilities, family income, distance from house to universities etc. (ClassbasePro, 2012).

Back-to-school initiative was introduced with the help of MoESD in 2012, with the purpose to give the second chance to dropout leaners to start their studies. Many students took advantage of the opportunities and were admitted at different levels. There are few HEIs in Botswana offering open and distance learning programs where students can join their studies at the ease.

There is the paradigm shift in tertiary level education, where teacher-centric education is moving towards learner-centric education to create a viable and productive learning environment. In this era, students are motivated with education through technology. E-Learning enables learning in faster, efficient and more entertaining way (Rajendran, 2010). In the era of student-centered learning and constructivism methodology of teaching, it is imperative for all higher education institutions to provide hands-on experience to all students. It is easy to provide such activities in classroom context; the main concern and issue is to equip online distance learning students with same knowledge and skills. The need to implement vLabs was born from the theory of constructivist learning and experiential learning. Since most of the topics in computing program required 'constructivist practices' and satisfying those experiences in distance learning education is very critical. Empirical studies have proved that virtual laboratories are cost effective and provides access to real systems (Wolf, 2010). Remote access to educational resources was 15

explored long back for online distance learning mode of education. vLabs provide new opportunities for learners to access advanced learning for all the fields and access from anywhere to anywhere. The Constructivism learning is the theory where learners develop their knowledge by getting involved in the task. Constructivism-learning environment is where learning takes place through real-life experience to construct knowledge (Darby-White, 2015). It is the approach where students will learn and improve their knowledge by practice (Ngoyi, 2015). Constructivist approach helps student for being active during learning process. "Constructivism approach where students research, inquire, test, seek solutions, wear scientist shoe and deeply reason about the concepts of concerns", (Tatli, 2012). Virtual labs with its constructivist-learning environment helps to improve student engagement and employabiility skills in STEM education (Han, 2015). "Technology plays a significant role in enhancing constructivism because technology and constructivism are used together to foster learner's understanding of lesson material", ((Ngoyi, 2015)).

This study was conducted in Botho University. Botho University is the private higher education institution in Botswana, established in 1997. Botho university is offering bachelor's degree courses in accounts, business management, computing, primary education; Master's degree courses in higher education, mobile computing, computer system management and some of the certificates course in online distance learning mode of education. There is a dedicated department in the university, named Blended and Distance learning (BDLC). This department is mandated to deliver quality education to their distance learning students. Equipping online distance learning students with practical skills, same as, students are gaining from real labs, is very crucial. Vlabs are helping BDLC department to provide the quality experience to their online distance learning students. Empirical studies have proved that Vlabs are strong components for STEM education, with its richest experiments experiences.

1.3 STATEMENT OF THE PROBLEM

Knowledge, skills and competencies gained by online distance learning students are the biggest concern for higher education institutions. With the aim to enhance students' learning experience, Botho University has implemented the virtual labs for their distance learning students to practice computing programs, but distance learning students are not utilizing the virtual labs adequately. 16

Laboratory activities increase students' interest and motivate them for self-studies. Virtual labs have alleviated laboratory capacity problem by allowing distance learning students to practice critical computing skills required by real world work environment (Lampi, 2013).

Due to lack of interaction between instructors and students, teaching practical modules to online distance learning students is the biggest challenge. In the case of insufficient labs and equipment in satellite campuses for distance learners, virtual lab is an effective solution. Laboratory activities are essential part of training for practical courses. Effectiveness of teaching practical courses with vLabs to online distance learning students and evaluating student's skills with real lab is very challenging.

This study has evaluated the virtual labs implemented by BU for their online distance learning students. This study has collected the lecturers' perception on design of virtual labs and effectiveness of vLabs on students' learning.

1.4 SIGNIFICANCE OF THE STUDY

This study is an assessment of vLabs, will help to design and implement vLabs efficiently in Botho University. Virtual labs have great potential for improving online distance learning students' knowledge, skills and competencies for computer practical and technical programs (Polly, Marcus, Maguire, & Velan, 2014). This study helps to improvise the students' experience by proper planning for development and implementation of interactive vLabs for practical courses for online distance learning students. Empirical studies have proved that the virtual labs are effective eLearning tool in teaching computer practical courses (Lampi, 2013). Radhamani (2014) has concluded with her study that practice and experiments with virtual labs has positive impact on student's performance. Higher education institutions can implement efficient virtual laboratories where instructors can facilitate education and leaners can acquire better skills and experience and capable to work in real environment.

1.5 RESEARCH AIM

The main aim of this study is to evaluate the effectiveness of virtual labs on students learning. E-Learning has changed the face and value of education. Through eLearning, learner can get access to education from anywhere and at their convenient time and cost. To enroll more number of

students, higher education institutions are motivated to offer course through online distance learning mode of education. Virtual labs (vLabs) are valuable e-learning tools for online distance learning students, to design and perform their own simulation experiments (Carla Martin). Providing quality education and experience on practical modules/courses with hands-on activities to distance learning students is the big challenge.

The purpose of the study is to enhance the students' experience and learning in distance learning mode with virtual labs to gain knowledge, skills and competencies as required by global workplaces. This study has evaluated the vlabs implemented by Botho University for their computing programs for online distance learning students from lecturers' perspectives.

1.6 RESEARCH OBJECTIVES

This study seeks to evaluate the effectiveness of the virtual labs on students' learning and the research objectives are as follows:

To evaluate the effectiveness of the design of vLabs developed and implemented by BU. To establish the strategies that can enhance students' participation in virtual labs

What are the strategies that can be applied to enhance students' participation in virtual labs.

To measure the effectiveness of vLabs on students' learning through lecturers' perspectives.

To establish a vlab framework that can effectively enhance student learning.

What framework can be established that can effectively enhance student learning

1.7 RESEARCH QUESTIONS

What are the components of effective vLabs?

What are the challenges faced by students in using vLabs?

What are the impacts of vLabs on student's performance?

What are the strategies to be employed for effective implementation of vLabs?

1.8 METHODOLOGIES

The objective of this study was to determine the effectiveness of virtual labs for undergraduate online distance learning students of computing program. This study used quantitative research approach to evaluate the usage at Botho university through lecturers' perspectives. The closed-ended structured questionnaire and interview with technician method was used for collecting the data.

1.9 CONCEPTUAL FRAMEWORK

The following proposed conceptual framework (figure 1) informs the study. There are mainly four components that contribute to the successful implementation of the virtual labs in higher education institutions for its online distance learning students. The four major components are virtual environment, services and support, accessibility of the components of the vLab, and finally, the role of the user. Selection of appropriate software and tool will help to develop and implement vLabs as per the users' requirements. Sufficient support will help non-IT students to learn efficiently using vLabs.

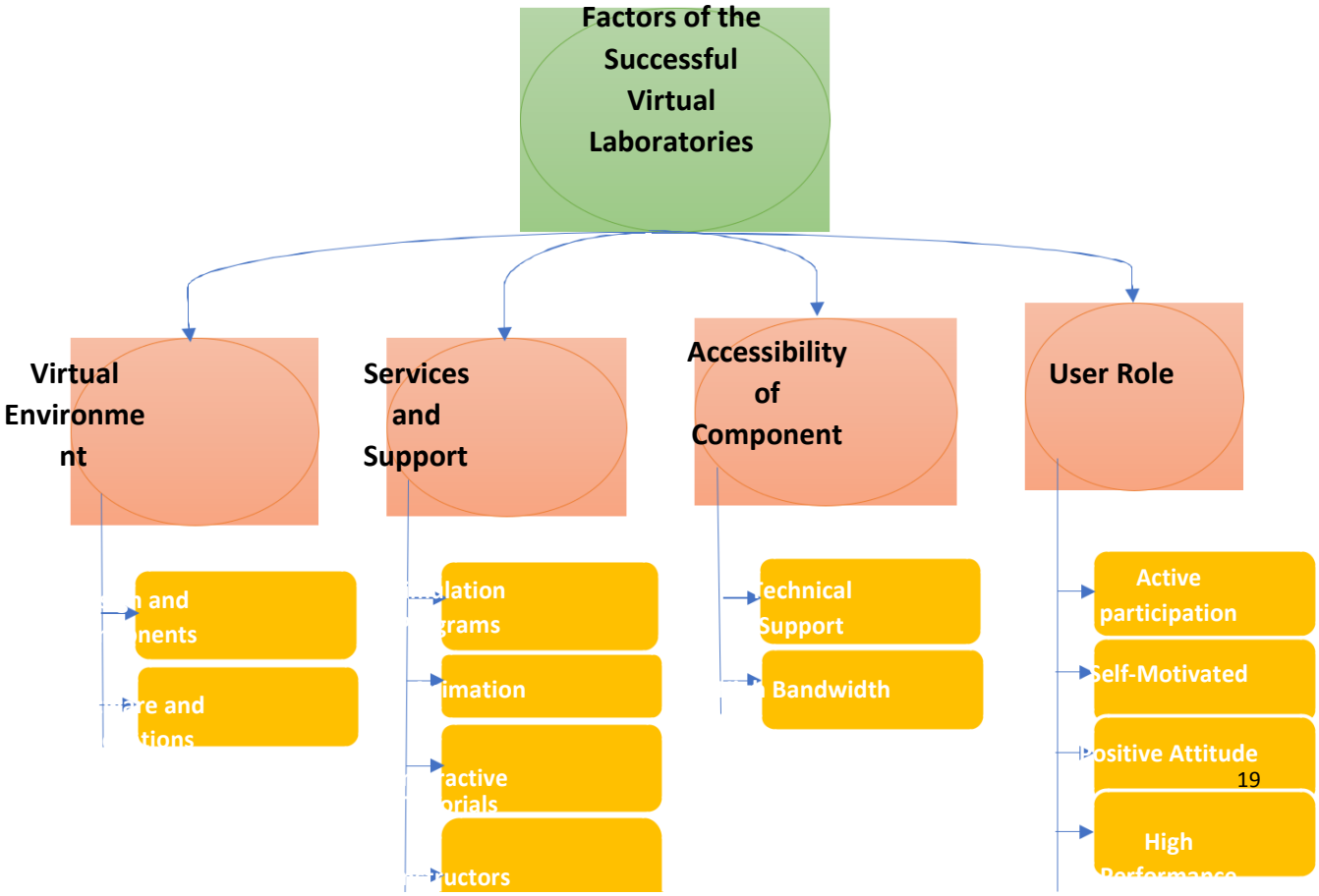


Figure 1: Factors affecting the efficiency of Virtual Laboratories

1.10 SCOPE OF THE STUDY

This study is concentrating to evaluate the usage of virtual labs used by higher education institutions within Botswana. Gaborone is the capital city of the Botswana and most of the higher education institutions of the country are situated here. Due to the limited time, this study will cover the Botho University, one of the private universities situated in capital city, Gaborone in Botswana.

1.11 DEFINITION OF KEY TERMS

1.11.1 E-LEARNING

e-Learning is electronic learning where learning takes place through electronic media like computers, internet and user interactive programs like blackboard, virtual labs, padlets, yammer etc.

1.11.2 ONLINE DISTANCE EDUCATION

Venkata Subrahmanyam (2013) has defined distance education as education that focuses on teaching methods and technology with the aim to facilitate teaching and learning, on individual basis, to a student who is not physically present in traditional educational setting as classroom. This is the education where access is provided to learning where source of information and learners belongs to separate distance where education is not provided into classroom setting, it is provided through electronic means through internet.

1.11.3 VIRTUAL LABS

“Virtual labs are interactive simulations where students can perform their experiments, collect data and take assignments to assess their understanding. Virtual labs are the combination of

animations and interactive simulations to engage students in friendly environment" (Huang, 2004). "Virtual laboratories allow users to perform experiments on real systems via remote access", (Wolf, 2010). It provides most of the operational characteristics with ease to access. vLabs provides the opportunities to the leaners to experiment with the variety of inputs and evaluate their impact on the outputs, learn by doing for online distance learners. Rajendra (2010) recommend virtual labs to improve educational standards, and this is the classroom of future with living textbook.

1.11.4 EFFECTIVENESS

Effectiveness is the indicator focuses on measuring the desired and achieved outcomes to the objectives of the program (Australia Government - Productivity Commission, 2013).

1.12 SUMMARY

Virtual labs are imperative e-learning tool which enhance students experience on practical courses. Botho University has implemented the vLabs for their undergraduate online distance learning students, but students are not utilizing the vLabs adequately. The quantitative research method is used to evaluate the implementation of vlabs from lecturers' perspectives. Literature review is discussed in next chapter.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter provides the review of the relevant literature in the area of vLabs in Higher Education Institutions. This chapter will discuss the history and need of virtual labs in Botswana. This chapter discusses the literature on students' experience and performance in virtual labs. This chapter will also put light on the factors proposed by empirical studies to implement virtual labs effectively and efficiently.

2.2 HISTORY OF E-LEARNING

E-Learning is the form where learning, teaching and education is supported using digital technology. This is interactive two-way process between teacher and student through internet technologies (Zuvic, 2017). The computer-based education has massively influenced the current learning environment. This type of education is flexible, supports self-learning and meets rural and urban educational requirements with limited resources (Radhamani et al., 2014). Due to limited resources and increasing demand for tertiary education, higher education institutions in developing countries are opting eLearning education, due to its features (Adams, 2016). This is the student-centered leaning era where more emphasis is given on creating a viable and productive learning environment. E-learning is the method and practice that enables learning in fast, efficient and entertaining ways by implementing technologies (Rajendran, 2010). Students are preferring use of digital media and technology in their studies (Jens, 2017).

Incorporating ICT in education can empower the country's economy and make it competitive worldwide. Developing countries are facing numerous challenges in promoting e-learning for online distance learners. Study conducted in Thailand, reported positive response of learners towards acceptance of e-Learning. Major challenges faced by learners in the country are limited access to computers with inconsistent quality of Internet, lack of awareness and technical

support, due to lack of training instructors who are pedagogically unprepared to use an online learning system (Adams, 2016).

2.3 HISTORY OF ONLINE DISTANCE EDUCATION

Online distance education has grown tremendously in last few years and many benefits are associated with it like accommodate different learning styles and schedules; uses various educational instructional resources and tools; supports self-directed and self-paced learning method and allows learner to have access to multiple communication channels (Elliot, Kukula, 2007). Online distance education mode has potential for lifelong learning and transitional education (Dewey, 2014). There are many political, economic, social and technical factors that impact the implementation of online distance courses. Online distance learning education and enlarge the scale of population (Bourne, 2005). Online education is becoming long-term strategy for HEIs, so it is imperative for them to provide quality online programs (Bonk, 2006). With the advancement of technology traditional labs are moving to the virtual environment and it has positive impact on students learning.

2.4 WHAT ARE VIRTUAL LABS?

Definitions

1. According to Zhao (2015), "Virtual Laboratory is an interactive environment to conduct simulated experiments, it empowers students to create information on internet from the physical world. Remote laboratory access allows students to practice experiments from anywhere and anytime. Virtual laboratory has greatly enhanced the flexibility of the education and labs" (Zhao, 2015).
2. According to Srivastava, "*The idea of virtual laboratory is to provide students a chance to perform experiments using the internet and visual aids without having the equipments at their end. The Virtual lab program presents a unique opportunity to boost the quality of engineering education, deepen understanding, and provide the necessary practical skills to young minds through cost effective outreach and distance learning activities*" (Srivastava, n.d.).

3. “Vitual labs are designed to simulate experiments closely to traditional physical labs with the purpose of imparting comparable knowledge and skills to learner” (Pearson, 2015).
4. “*Virtual Lab is an on-demand application delivery solution. This solution enables applications to be centralized, virtualized, and instantly delivered as a service to users via any computer or mobile device connected to a network at any location, on or off campus. A VL session provides access to applications, shared files, network and USB printers, and CCI printing. Access to VL is available 24/7*” (The University of North Carolina, 2017).
5. “*A virtual laboratory is an on-screen simulator or calculator that learners use to test ideas and observe results. An interactive interface will walk the learner through the problem scenario until a solution is determined*” (Andriotis, 2016).

Virtual labs are the platform where students can experiment simulation for practical courses. This is the efficient tool for online distance learning students to practice and have remote access to resources in the absence of physical labs.

2.5 HISTORY OF VIRTUAL LABS

According to Rajendra (2010), no any pre-requisites required or essential as only the basic knowledge of accessing computers is enough. Virtual lab is an interactive product that assists students to perform their experiments in step by step procedure, by giving proper instructions and extending its limitations. Virtual lab encloses infotainment, edutainment and enrichment (Rajendran, 2010). Online virtual laboratories bring new type of learning opportunities for students to have an experience of risk-free, repeatable experimentations and simulation (Lim, 2017). Implementation of virtual labs is easy and cost-effective compare to traditional labs, in terms of time, finance, limited resources and insufficient laboratory protocols, inadequate technical support (Radhamani et al., 2014).

Torres (2017) has also concluded with their study that the virtual labs has improved the user experience as virtual environment allows immersion to a physical setting with 3D animation technologies. They implemented virtual laboratories for technical training and students’ experience with virtual laboratories is very positive as it helps in strengthen the academic

contents and improve students' performance. Using virtual labs has prone to have less accidents as it is in traditional labs (Torres, 2017).

In Greek secondary schools, virtual labs are implemented to provide educational network service so that learners can become familiar with the information society and new technology. Virtual laboratories motivate students towards practice with real process, it also significantly reduces the labs setup cost and dangerous STEM experiments can take place without any physical damage (Antonios Alexiou, 2004).

2.6 VIRTUAL LABS IN BOTSWANA

Botswana has made great evolution in education development. Botswana's vision is to become the center of excellence in tertiary education and attract foreign students. Botswana's tertiary educational policy '*Towards a Knowledge Society*', is aiming to enhance relevance, enhance quality, and increase access with the diversity of choice (University World News-African Edition, 2008). Tertiary education system of the country together with public and private institutions, are motivated to revise their curriculums as per the labor market demand and providing education in all possible modes. With the aim to increase the access to the education, higher education institutions like University of Botswana, BOCODOL, Botho University, eZone institutions, are offering their courses in online distance learning mode. Other challenge is to provide the same knowledge, skills and competencies to online distance learning students. Virtual labs are the solution where students can experiment with no-harm. Virtual labs are the solutions for institutions with limited resources and with low maintenance cost.

Major challenge for higher education institutions in Africa are poor physical facilities and infrastructure for practical training and lab exercise. Many institutions have experience of no infrastructure improvements due to insufficient budgets and overdependent on public budgets, but development of ICT has provided the opportunities to such issues with their affordability in the terms of costs. Virtual labs are the example of ICT development. The virtual labs are interactive environment for creating and conducting simulation experiments (Tambo, 2017). University of Botswana, BOCODOL, Botho University and eZone training institution, are the handful institutions in the country, that have implemented virtual labs for their different STEM

programs. Botho University has implemented virtual learning environment for their online distance learning students, where they can have access to all the learning material and resources from anywhere they are. This platform allows them to study in flexible manners and have an opportunity interact with lecturers and peers (Botho University, 2017).

2.7 DESIGN OF VIRTUAL LABS

Virtual labs are the combination of text, animated tutorials, illustrations, links, simulated experiments with a broad range of concepts. According to Hassan (2014), the virtual lab designed for the topic digital logic at Universiti Kebangsaan in Malaysia, had excellent balance of software approaches for teaching logic design to IT students. The DigiLAB designed for logic design was capable to run as standalone applilcaton through web browser and had animated environment with textual tutorial links, demonstrations, interactive modules together with user guide, practical guide, experiments, theory and questions (HASSAN, 2014).

Design of virtual lab plays very important role. Effectiveness, efficiency and user friendlyness can be measured by the nature of the tool. Java applets were used to develop the virtual labs for Botho University, which helps to create flexible and interactive interfaces for students. User manuals, with 3D interactive tutorial were provided to utilized available components of virtual lab to achieve the objectives of the programme. Students can perform simulated experiments with safe environment. Accroding to Mercer (1990), “virtual labs should be flexible; consistent; interactive to manipulate objects of an experiments by using availble control panel and labs should include a hypertext system that impose a logical organization on the set of objects, provide texual description and should be able to browse through the corresponding addess to demonstrate the experiment to a novice user”.

2.8 OBJECTIVES OF VIRTUAL LABS

Virtual labs provide remote access to Labs in STEM education, it enthuses students for independent learning through remote experiments, to share costly equipment and resources, which are limited, and students can avail various learning tools and other resources, also helps in instant feedback (Bates, 2014; Lampi, 2013; http://vlab.co.in/). Students can get access to all the resources of virtual labs from anywhere with assigned password, student can practice their

experiments well in advance and any number of times until they get expected results (HASSAN, 2014). The main objective of these laboratories for STEM education is to provide the environment where students can conduct simulated experiments, capable to encompass abroad range of concepts. Access to real labs are limited and time bounded but with virtual labs students can experiments from anywhere and anytime and also can attempt any number of experiments until they get results as required with interactive 3D tutorials and discussion forums. Virtual labs are an attractive research and learning environment.

Most common objectives for setup virtual lab for students is, to motivate them for conducting experiments on their own interest, to reduce maintenance cost for institutions, to remotely access to laboratories in various courses and with virtual laboratories can help users to build up their knowledge and improve fundamental concepts with practical work. It benefits students to solve a large set of complex problems through the design and construction with new approach. Students can understand more detailed experiments through changing different variable or parameters (Kumar, 2016).

According to Andriotis (2016), the development costs of virtual labs are high, but once it is established it will never blow up. Virtual labs prepare learners to use real laboratories. Virtual labs can also be used for abstract leanring environment. It simulate any level of scale , complexity or abstraction. VLAB creates a recher eLEarning experience and serves as good preparation. vLabs provide safe environment for discovery, learners can correct their misconceptions and compare their assumptions with reality. It also encourage learners for exploring and manipulating for variables in an independent way (Andriotis, 2016).

2.9 BENEFITS OF VIRTUAL LABS

Majority of pedagogical studies have indicated that the virtual labs have positive student's preference response for science courses. Virtual labs are future of higher education. Virtual labs are becoming more mainstream in improving STEM education (Nagel, 2013). Virtual labs have overcome some of the problems of traditional labs. It allows students to repeat their experiments, to better understand the results with no limit of space and time. Virtual labs also support the ability to experiments things which are too dangerous, global or long to go in a

traditional lab, less chances of any real damage and exploit. Virtual labs are efficient and effective E-Learning tool for Science and Engineering students as they can practice any number of experiments until they will get desired results. Virtual labs are effective also for research scientist in the form of interviews and discussion forums (Scheckler, 2014). Among these advantages, there are many disadvantages are associated with the implementation of virtual labs. One of the biggest disadvantage is lack of face-to-face interaction with supervisors, students lack the interaction with experienced students and no exposure to real labs and hardware components. Practice with virtual labs requires adequate bandwidth to access its interactive components (Scheckler, 2014). Despite of these disadvantages, virtual labs are still very popular. vLabs delivery better service at lower cost and with high security and reliability (IBM Global Education, 2007).

According to Alexiou (2004), practical experiments for science students are important for educational process. Virtual laboratories are the solution not only for online distance learning students, but also for the institutions facing lack of resources, constrained with time and funds. Major benefits associated with virtual labs are resource sharing, broadly access to eductional and research material, to perform scientific experiments safely which could be dangerous in real labs. Virtual labs also enhance critical thinking, innovation and team-work skills of learners which are required for today's job-market and one of the most important advantage of using vLabs is sharing resources between geographically distributed educational institutions and user (Lynch, 2016). Hybrid virtual lab trained students to acquire research skills rather than laboratory skills. These labs give students the opportunity to learn and complete the task at their own pace which make learning environement more convenient for online distance leanring students compare to conventional labs. Virtual labs provide more time and flexibility to learners which helps them to enhance their knowlesge, skills and performance. Hybrid virtual lab format is more effective than the conventional laboratories (Bactol, 2017).

Virtual labs are the solution for problems faced by teachers in traditional labs which includes instant feedback, engaging and motivating students, and where students can work as per their pace (Lynch, 2017). Practicing experiments through virtual labs are motivating and engaging students. It includes animations and gamiifcation which makes study fun and create interest for

students (Morris, 2012). Virtual lab (simulation approach) is used to a greater extend to the real traditional labs due to limited real components and resources. According to the study conducted in Tanzania, students considered both simulation and hands on lab as useful teaching method to enhance teaching and learning of computer networking skills (Shimba, 2017). Alexiou (2004) has listed some of the important benefits of using virtual labs over tarditional labs are resource sharing, reduction in travel time leads to productivity enhancement and scientific investigation standards are established in area where practical experimentation is a required part of research.

According to Malani (2017), students can access VLABs any-time 24x365; remote labs are closer to physical labs; it reduces infrastructure expenditure; it also helps in reducing administration time needed for scheduling and setting-up real labs; provides safe and secure staging environment to practice dangerous experiments and centralizedinfrastructure results in higher infrastructure utilization (Malani, 2017). According to Ngoyi (2015), major benefits associated with virtual learning includes flexibility, collaboration, expending educational access, providing high quality learning opportunity to online distance learning students, allowing for educational choice – alternate traditional labs, achieving administrative efficiency (Ngoyi, 2015).

Study conducted in Egypt has proved that a developed virtual lab is useful tool for teaching. VLABs allow students to practically verify the results they obtain analytically, enable students to find bugs in their projects. Virtual labs are powerful eLearning tools with less cost compare to real labs. This system is useful for distance learning students where physical labs are not feasible (Saleh, 2009). Virtual labs are less time-comsuming than the traditional labs. Virtual lab provides safe environment to students, students have to be more careful in tradittional labs during performing experiments (Gould, 2014).

2.10 LIMITATIONS OF VIRTUAL LABS

Virtual labs are criticized for the following reasons:

Learners require basic knowledge of computer and internet (Fok (2009); Muthusamu). As per the study conducted in Hong-Kong, in the department of Electrical and Electronic Engineering (EEE) to investigate the effectiveness of virtual laboratories, they concluded that virtual labs are not suiting to first year students, these labs are more suitable for senior students, those have basic

knowledge of computer and internet. This study concluded that the virtual labs are not the true substitute for traditional labs, but these labs can be used in addition to traditional labs to enhance and facilitate learning outside laboratory hours (Fok, 2009)**.** Managing computer files and working in online learning tools and software can sometimes become complex for students with beginner-level computer skills and sometimes slow internet connections can make accessing course material frustrating for students. Virtual lab's lack instant feedbacks to students' work and experiment results. VLABs also lacks learners' hands-on experience on hardware machines. Due to lack of interaction with students, teachers experience difficulty in motivating and engaging students to carry out experiments (Ghergulescu, 2017).

Virtual labs reduce cost is just a myth. The setup cost is comparatively low for virtual labs than traditional labs, but the virtual lab software becomes obsolete so fast, and there is the need to update them so frequently which increases the maintenance cost for vLabs (Pearson (2015); Muthusamu). Scheckler (2014) has concluded with his study that virtual labs alone are not sufficient for students to achieve all the learning outcomes (Scheckler, 2014). E-Learning becomes the necessity of the HEIs, despite many challenges are associated with the implementation of e-Learning which are learning style, pedagogical, technological and time-management etc.

The study conducted in University of Malaysia with engineering students has shown that virtual labs can be an alternative for real/traditional labs, but they cannot replace traditional labs due to realism. Data manipulation by learners to obtain a specific outcome or result that favors them may affect the ethics and professionalism (Muthusamu). Virtual labs cannot be used to teach most generic laboratory skills like how to use specific item of equipment or to promote education on ethical issues, vlabs are alien way of learning, students lack time management, collaboration and peer-assisted learning (Lewis, 2014).

Study conducted in Tanzania has concluded that "Virtual labs (simulation approach of learning) enables learner to acquire less of practical skills and problem-solving skills like configuration and troubleshooting skills in computer network skills. According to the findings of the study, learners

were able to configure VLAN with difficulty, but they failed to troubleshoot and verify the connectivity due to limited practical skills" (Shimba, 2017).

2.11 FACTORS THAT CONTRIBUTE TO ENHANCE STUDENT LEARNING WITH VIRTUAL LABS

In student-centered learning educational bodies should concentrate on all learning styles of students. The main learning styles are classified into four methods – auditory learning, visual learning, reading/writing learning and kinesthetic learning (Rajendran, 2010). Auditory learning where students learn by hearing. This is the traditional methods where students will learn from what teacher has told them. The success of this leaning style depends on the knowledge level and oratorical skills of the teacher and hearing power of the learner. In visual learning students learn from what they have seen. They do not bother about how real system works. In third level of learning style students learns through visuals combined with auditory. This mode of teaching is called Computer Based Training, was popular for long time. through this style learners understand how the system look like and how it works. Now the need was to hands on the practice for more better understanding which was fulfilled by fourth learning style the kinesthetic leaning.

Virtual labs have great educational potential as they provide the opportunity with hands-on activity which helps learners to '*learn by doing*'. Virtual labs allow users to explore variety of scenarios by changing the inputs and observing their effects on outputs (Rajendran, 2010). Study conducted in Amrita University in India has concluded that the virtual laboratory experiments are very effective when reagent and equipment are expensive, the real lab setup cost is high; time requirement does not fit into the classroom schedule, access to traditional labs is limited compare to virtual labs; ethical concerns; difficulty in results interpretations; safe environment – handling of sophisticated instruments, use of hazardous material etc. virtual labs are strong alternative for classroom laboratory environment (Radhamani, 2014).

2.12 NEEDS OF VIRTUAL LABS IN ONLINE DISTANCE EDUCATION

Virtual labs play crucial role in evolution of practical training for STEM as they face challenges in traditional labs, and virtual labs are the best solution for students to increase practical experiments for STEM education without limitations posed by time, space and resources

(Ghergulescu T. L., 2017). Rajendran (2010) with her study has concluded that virtual labs are cost effective, the cost spent ot it is worth as these labs help students to experiment different results from their ease of place like work, home etc. Learners can learn different concepts independently which helps in improving their performance and skills by exploring and hands-on activities. With lack of facilities to setup laboratories for online distance learning students in rural area, virtual labs can be achieved with virtual labs can help to achieve those needs (Rajendran, 2010).

According to Encalada (2017),

> "E-learning uses the Internet and digital content for learning and education activities, that takes full advantage of modern educational technology to provide a new mechanism for communication and a learning environment rich in resources to achieve a new way of learning", and "One of the most interesting applications of E-learning are virtual labs based on cloud computing". "A virtual lab is a collection of computing resources, storage and network provided by an educational organization for educational purposes. A virtual lab provides the necessary infrastructure to achieve a classical lab; the resources provided are accessible via the Internet. Therefore, moving from traditional labs to virtual labs is essential".
>
> […] Research has shown that hands-on experience in the laboratory plays a central role in education. This is largely due to both its strong impact on student learning outcomes and performance and on its presumed efficacy for professional preparation. However, until recent years, physical, hands-on laboratory experiences were the only experiences available from which these conclusions could be drawn. Lately, data has been found that reveals no significant difference between outcome achievement between a physical, hands-on laboratory experience and a virtual, hands-on laboratory experience. Despite, "there is clearly a
>
> need for learning with physical objects at some point, and the key is determining where along the educational process that need lies" [7]. The two methodologies can be considered equally "effective" with regards to outcome achievement [8]. (Encalada, 2017)

Some universities have difficulties in providing scalable, flexible, and accessible information technology (IT) services to their students in traditional computer labs. There are many limitations such as hours of use, lack of equipment, complicated repair and maintenance, scattered locations of the laboratories, high costs of hardware and software, and contracting personnel for the IT department [..], Encalada (2017).

There are many benefits associated with implementing virtual labs such as there is no limitation of time place and number of experiments to perform for students. Virtual labs help students'

competencies and skills to live and work in today's knowledge society and globalized world, it also attracts students towards studies and career (Argyri, 2015). Virtual lab provides the necessary infrastructure to achieve a classical lab, resources are available through internet, moving from traditional labs to virtual labs is essential. Virtual labs are interesting application of E-Learning based on cloud computing. Virtual labs are the tutorial system to teach practical hands-on IT skills, which encompasses the trends in education and mitigates the problems detected in other models of education (Sequera, 2017).

According to Zhou (2009), there are number of challenges associated with real-world networking laboratories which includes lack of funds to establish and maintain heavy hardware and software sufficient quality labs; lack of secure network environment; expert to manage lab; access time limitation with real labs (Zhou, Xing, & Chen, 2009). These challenges associated with real labs are increasing demands for virtual labs. Virtual lab arises for several reasons which includes supporting online distance education; potential for resource sharing and cost saving; potential for improved educational outputs. VLABs are well suited to support educational objectives concerned with developing professional skills and conceptual understanding. Virtual labs are more convenient, and location and times were widely distributed (Burd, 2009).

2.13 EFFECTIVENESS OF VLABS ON STUDENTS' LEARNING

Empirical studies show that virtual labs have positive impact on student learning, academic performance and achievements. It assists in enhancing autonomous and guided educational methods and proved better compared to traditional lab, in enhancing student's performance (Radhamani et al., 2014). Studies have proved that students are very comfortable and interesting in using virtual laboratories. Students are not worried about any damage of resources due to wrong results, they can utilize resources in their convenient time and place. They can practice any number of experiments; there is no need to wait for availability of hardware resources or traditional labs. 90% of students recommended virtual labs incorporated with tutorials instead of textbooks. Virtual labs with animated tutorial has great impact on students' mind, students feel fun to study through virtual labs. They can remember things for long time. Virtual labs

embedded with computer-based tutorial are the future of tertiary education and it serves quality education with quality experience (Rajendran, 2010). Virtual laboratories have improved the students learning and task performances through simulation programs and computer animations (Tuysuz, 2010).

Lynch (2016) also has recommended virtual labs through its study to utilize for STEM subjects as it helps in performing safe experiments in practical subjects without the usual limitation of time resources and space.

2.14 CHALLENGES FACED BY STUDENTS IN UTILIZATION OF VLABS

During the course of this literature review, limited information was available that was directly related to challenges faced by learners and instructors those are users of virtual laboratories. What challenges were discovered were not directly related to virtual laboratories. Most challenges include the bandwidth issues, technology change and non-IT background of learners. Virtual laboratories are the best alternative for physical laboratories for online distance learning students to equip the with the practical skills as required by employers. Ngoyi (2015) has categorized challenges as social presence, equity and accessibility to technology, learning style, high cost of equipment, teacher resistance, technological confidence, lack of motivation and commitment in students (Ngoyi, 2015).

Major challenges associated with the usage of vLabs is the internet speed, as many students are accessing together can affect the results of the experiments (Scheckler, 2014). “Virtual computing labs pose significant challenges in configuration, operation and administration” (Burd, 2009). Non-technical students can be disoriented and overwhelmed when operating virtual computing labs, institutions can address this issue by devoting sufficient resources for training, user-friendly interface design and ongoing support for both students and faculty users. VLAB workstation access to network resources is limited to minimize the susceptibility to malware. Due to this, students have to transfer files via FTP or email to other computer for printing, thus saving and printing documents with VLABs are more cumbersome (Burd, 2009).

Another biggest challenge students faced using VLABs is lack of interaction between instructors and peer-learners. VLAB activities does not support group activities and discussions. Sometimes

due to poor bandwidth, video performance of three-dimension simulated experiments is low. VLAB computer are more vulnerable to security problems such as network-based attacks. There is need to put extra consideration on security issue while designing interaction VLABs. Higher Education Institutions, those implement VLABs, should make security planning, implementations and monitoring a high priority (Burd, 2009).

2.15 STUDENTS' PERSPECTIVES AND ATTITUDE TOWARDS PRACTICES IN VLABS

Virtual Lab applications have positive impact on students' attitude and achievements (Tuysuz, 2010). Students are enthusiastic towards experiments and simulations with virtual laboratories and its 3D animated demonstration. Students felt virtual laboratories are user friendly, but critics have also mentioned that only self-motivated and good students are performing well with virtual laboratories (Scheckler, 2014). Virtual labs create lots of experience and knowledge, it motivated students and simulation programs and animated tutorials help to remember contents easily and in long term (Tuysuz, 2010). Embedded computer animations are effective in increasing students' motivation and participation in laboratory activities.

Study conducted in California has concluded that students those opted online virtual labs have responded positively towards the VLABs. They commented on its convenience and flexibility with regards to time, overall performance in the course did not differ from rest of the students using real labs (Sommer, 2003).

Study conducted in Australia has shown that computer-based simulation material is best alternative for traditional labs. It benefits students with large amount of supporting and reinforcing information, so that students can work on their own pace. Students can experiment practical material even after hands-on lab sessions. Some of the students also commented that just viewing the experiment simulation are not sufficient. Hands-on experience is required to gain practical skills. So, this study has suggested to use combination of both types of learnings (Franklin, 2001). Virtual labs offer safe environment to perform any exercises. Instructors can focus on teaching, not on technical issues with hardware components. The biggest benefit is it gives good practice to learners in safe environment. Students can feel and learn the simulated

experiments and practice on their own pace. Virtual labs give real-world experience to learner (McMahon, 2018).

According to Alharbi (2018), “Life-long learning is the one of the most important characteristics of learner in new era. It is important for undergraduate informatics academics students to include in hand-on experience in order to prepare them for real-world jobs. With limited educational resources and dramatically increasing number of students, efficient and timely access to physical computer labs is becoming challenging. The use of information and communication technology to support education has led to the emergence of innovative paradigms for teaching and learning. Simulation and virtualization tools provide effective and alternative approaches to help students gain essential informatics skills without the need to be in a physical lab. Qassim University has implemented portable virtual labs, students’ perspective on virtual labs is categories into strengths and weaknesses. Study has listed strengths as per student’s point of view: easy to use, improve productivity, interesting and interactive, support collaboration and support life-long learning. Whereas demerits are limited functionality, stability and hardware issues. This study has concluded that despite of challenges as compatibility and stability, VLABs serves as an easy and flexible tool for students to gain hands-on experience in informatics skills (Alharbi, 2018).

2.16 SUMMARY

Virtual labs provide rich interactivity in eLearning. The majority of the studies have shown that there is no any significant difference between the knowledge and practical skills learners are gaining from virtual labs and hands-on labs. There are rich benefits from implementing labs like sharing resources, reducing maintenance cost, powerful eLearning tool to provide practical skills to online distance learning students, safe virtual environment for students to perform dangerous experiments and remote access to labs (24x365).

CHAPTER 3: METHODOLOGIES

3.1 INTRODUCTION

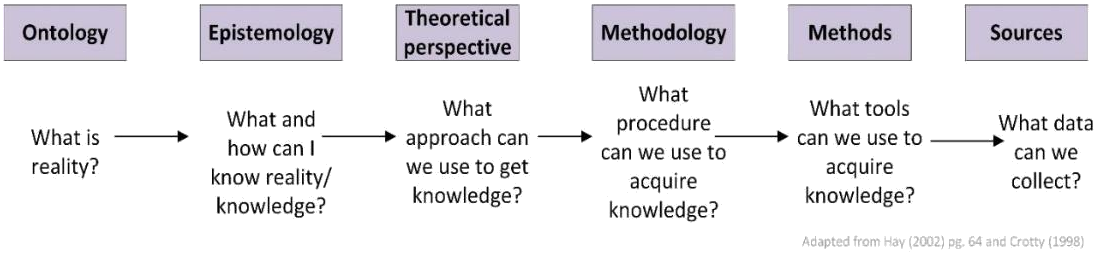
This chapter discusses the research approach that was used in this study. It includes research method and also describes the data collection procedures, and analysis.

The main purpose of the study was to investigate the usage of virtual labs for online distance learning students in Botho University. This study evaluates the knowledge, skills and competencies students are gaining with virtual labs are equivalent to what they can achieve with real-labs and if the skills and knowledge are sufficient to skills required by real-time workplaces. This study will also assess if there is an impact of virtual labs on student's performance and achievements.

3.2 RESEARCH PARADIGM

Research paradigm is the research process, is a worldview with set of assumptions regarding how things behave and how reality take place. Research paradigm includes elements like Ontology, Epistemology and Methodology, and axiology which helps researcher with how to conduct an investigation. It answers questions like what should be asked, what should be observed and how observations should be interpreted. "*The paradigm drives the research, building upon itself, becoming more solidified and realized*". The diagram below explains the relationship between the elements of research paradigm:

Figure 2: Research Paradigm



Anderson (2013) has concluded that there are basically four types of researches which includes positivism, constructivist/interpretivist, critical/transformative and pragmatic. Positivism is quantitative based which helps in discovering the laws that govern behavior. Constructivist covers qualitative studies by understanding from an insider perspective. Critical is postmodern to investigate and expose the power relationships. Pragmatic research covers intervention, interactions and their effect in multiple contexts.

The researcher has opted positivism paradigm as this is quantitative approach study. This study investigates the success of virtual lab for computing programs for online distance learning students. Investigation took place through closed ended questionnaires the structured questionnaires and data was collected from lecturers. To prove the validity of the collected data, triangulation study was conducted and for that purpose interview was conducted with the back-end technical person of the Botho University. This study is evaluating the virtual lab implemented by Botho University, a higher education institution in Botswana for computing and networking programs and recommending implementing for other programs like accounts, vocational, health and information science etc., wherever applicable. This paradigm concentrates on problem-solving instead of finding the truth (Anderson, 2013).

3.3 RESEARCH APPROACH

Research approach is the plan and procedure that involve the steps of broad assumptions to detailed method of data collection, analysis and interpretation (Datt, 2016). ***Quantitative Approach*** is basically associated with positivist and post positivist paradigm where data is to be collected and converted into numerical data to produce statistical calculations and conclusions.

This study was conducted through the quantitative approach for data collection and inductive approach for data analysis. Questionnaire was used to collect the relevant data. Close ended

questionnaire was designed for the purpose which included standard questions regarding the design and accessibility of VLABs, some sections were provided to give respondents' expectation and perceptions on area to enrich the students' learning and experience on VLABs.

3.4 TIME FRAME & LOCATION

This study was started in July 2017 and was completed in December 2017, six months' time. Findings of this study was concluded in April 2018. This study has covered the Botho University, situated in Gaborone city of Botswana. This study has focused the two programs offered by faculty of Computing named as Bachelor of Science in Computer Science and Bachelor of Science in Network Security and Computer Forensics.

3.5 RESEARCH DESIGN

Research design is a blueprint for conducting a study with maximum control over factors that may interfere with the validity of the findings (Langen, 2015). This study is of descriptive type because the purpose of this study is to obtain the picture of lecturers' opinion of practice with VLABs for their computing program with the view to improve the standards of usage of VLABs for online distance learning students.

3.6 POPULATION AND SAMPLING

3.6.1 Research Population

Research Population included the instructors of distance learning course and the back-end technical team of the vLabs. Research will also keep the second plan ready in case selected instructors are not available to avoid the delay in study. Campus Nexus system was used to retrieve the list of lecturers instructing distance learning courses for the current semester (July-December 2017).

3.6.2 Sampling Process & Techniques

Statpac organization who helps to conduct surveys, has classified sampling techniques into seven categories. First is random sampling, where each member of population has equal chance of being selected. Second is systematic sampling in which members are being selected after calculating the sample size. Then the Nth record is being used to select sample members from

list of population. Stratified sampling techniques which is third on the list which used probability method and reduces sampling errors. In this technique, researcher first identifies the stratum and their representation in population. Stratum is a subset of the population that share at least one common characteristics. Convenience sampling is used in exploratory research and this is nonprobability method often used during preliminary research. Fifth technique on the list is judgement sampling, where researcher selects samples based on their judgment. Quota Sampling is equivalent to stratified sampling where number of subjects from each stratum are filled by random sampling. Smowball sampling is last on the list, special method used when the desired sample characteristics is rare.

Sampling process includes the selection of groups of students and instructors for the study which will help to achieve research objectives by answering research questions (Langen, 2015). Sampling techniques is the technique to select appropriate sample from population. The data was collected through the use of a questionnaire and for triangulation purposes, interview was conducted with the VLAB technician.

In this study population is equivalent to a sample. Due to, small population size all 20 instructors, responsible for online distance learning courses in current semester were included in this study, and to verify the validity of the corrected data interview was conducted with the technical person who was responsible for developing and implementing the VLABs for computing program.

3.7 DATA COLLECTION INSTRUMENTS

It is very essential and crucial for researcher to choose a valid and reliable instrument for data collection. Validity, reliability and success of any research highly depends on the appropriateness of the data collection instruments. Main instruments of data collections are questionnaires, interviews and observations. "*Questionnaire is a data collection instrument consistent of a series of questions and other prompts for gathering information from respondents"* (Abawi, 2014). This instrument was invented by Sir Francis Galton. Questionnaire can be structured or unstructured. Interviews are one-to-one event where questions are asked for data collection. In interviews data can be collected by listening to individuals, recordings, filming their responses or combination of it (Abawi, 2014). Interviews are categories into four sections – structured interview, semi-

structured interview, in-depth interview and focused group discussion. This researcher implemented the closed-ended structured questionnaire and interview for this study. Interviews helps researchers to get in-depth phenomenological views of other research participants with regards to their experience on virtual labs.

3.8 VARIABLES

Regoniel (2012) has defined variables as simplified portions of the complex phenomena that we intend to study. Variables should be measurable so that can be used for statistical analysis. Variables are of two types dependent and independent. Variables help to measure if the certain research objectives are achieved or not and if achieved then to what level. There are three main parameters to evaluate for VLABs, design, accessibility and efficiency. The main variable that included in this study to evaluate about stated paramenters are components avaibale to students, availability of the vLAbs, skills gained by students using virtual lab. Researcher has used these variables to measure the level of objectives achieved.

3.9 VALIDITY AND RELIABILITY

Validity and reliability are imperative elements used to enhance the accuracy of any research work (Adefioye, 2015). Internal validity of any research is supported by the selection of correct research design and soundness and appropriateness of decision pertaining to opting instruments for sampling, data collection and data analysis (Bitonio, 2014). To ensure the reliability different questionnaire was designed for lecturers and interview was conducted with technical person to understand the in-depth view of respondent. Cronbach's alpha was used to measure the consistency of the study. Following provided figure is depicting the alpha value which is acceptable range.

Scale: Reliability

Case Processing Summary

		N	%
Cases	Valid	13	65.0
	Excluded[a]	7	35.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.799	.771	25

Figure 3: Reliability of the Instrument

3.10 DATA ANALYSIS

All the data were collected through the close ended questionnaire and interview from the lecturer and back-end technical person. The statistical calculations were conducted using the Statistical Package for the Social Sciences (SPSS 21) software tool.

3.11 ETHICAL CONSIDERATIONS

Ethical consideration such as consent from participants, confidentiality and consequences of the study were taken into the account and above stated was shared with all the participants. All the respondents were informed about the purpose of the study and importance of their role. Consent form is designed to sign by all the interviewee participants and will also ensure the confidentiality of their participation and data. A formal written approval was taken from the Botho University and Ministry of Education.

3.12 SUMMARY OF THE CHAPTER

This chapter contains the detailed description of the research design, population, technique of data collection, instrumentation and data analysis were presented. The next chapter presents the results of the study.

CHAPTER 4 – DATA ANALYSIS

4.1 INTRODUCTION

This chapter represents the data collected from the lecturers and technical staff of Botho University. This study investigated the effectiveness of the virtual labs developed and implemented by BU for its online distance learning students. In previous chapter, researcher has explained in detail the research methodologies. In this chapter researcher is disclosing the lecturers' perceptions on VLabs.

A close ended questionnaire was used to record the responses of the participants. The results of the study are divided into three sections where section A collected the biographical information of the respondent which includes gender, age, faculty and name of the department, section B talks about the research objectives which includes i) the components/design of virtual labs, ii) strategies to enhance students' participation in vLabs, iii) effect of virtual labs on students learning and iv) factors to implement effective vLabs; finally, section C was suggestion section, where respondents were asked to provide the ideas to improvise the effectiveness of the virtual labs and to record their expectations on vLabs. IBM SPSS 21 statistical package was used to measure the results against the objectives of the study.

This study has focused on the program offered through virtual labs by BU for their online distance learning students. Campus nexus system/application/portfolio was used to retrieve the list of program and courses offered by BU in current semester (July-December 2017). System has indicated 22 modules/courses are running in current semester in a distance learning mode for Faculty of Computing, out of which 20 practical modules are offering virtual labs. Therefore, population equals sampling, which is, 20 lecturers were used those were instructing these online distance courses.

4.2 RESULTS ANALYSIS OF DATA COLLECTION

4.2.1 BIOGRAPHICAL INFORMATION OF THE RESPONDENT

The first section of the questionnaire has collected respondents' biographical information and faculty and department they are working in. The following four questions helped in analyzing the gender, age, faculty and department of the lecturers.

4.2.1.1 GENDER OF RESPONDENT

Table 1: Gender of Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	14	70.0	70.0	70.0
	Female	6	30.0	30.0	100.0
	Total	20	100.0	100.0	

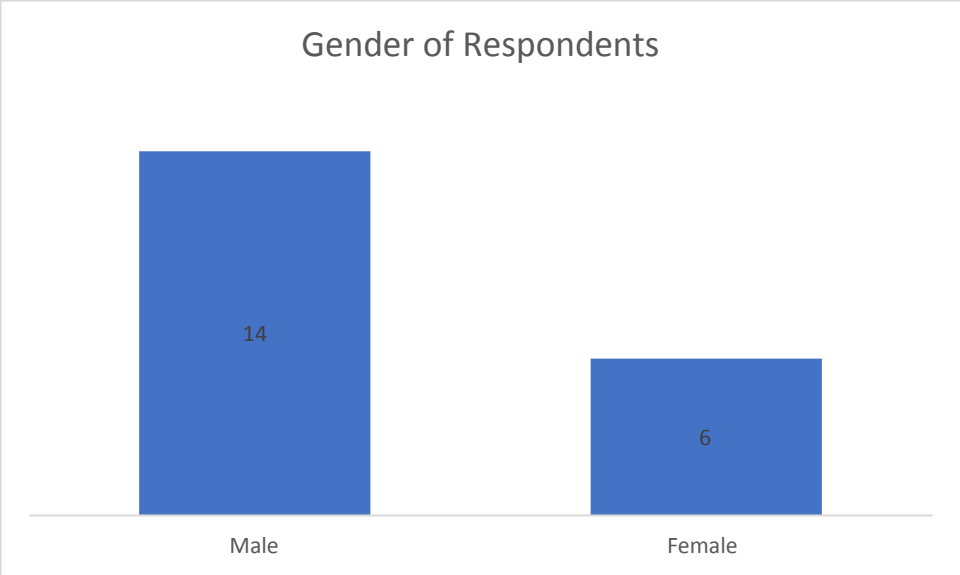


Figure 4: Gender of Respondents

The above table and figure has depicted that out of 20 respondents, 14 were males which is 70% of total participates and only 6 were females which is 30%. Majority of participates were males.

4.2.1.2 AGE OF RESPONDENTS

This question helps the researcher to collect the age variation of the participants.

Table 2: Age of Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	26-35	6	30.0	30.0	30.0
	36-45	12	60.0	60.0	90.0
	46-55	2	10.0	10.0	100.0
	Total	20	100.0	100.0	

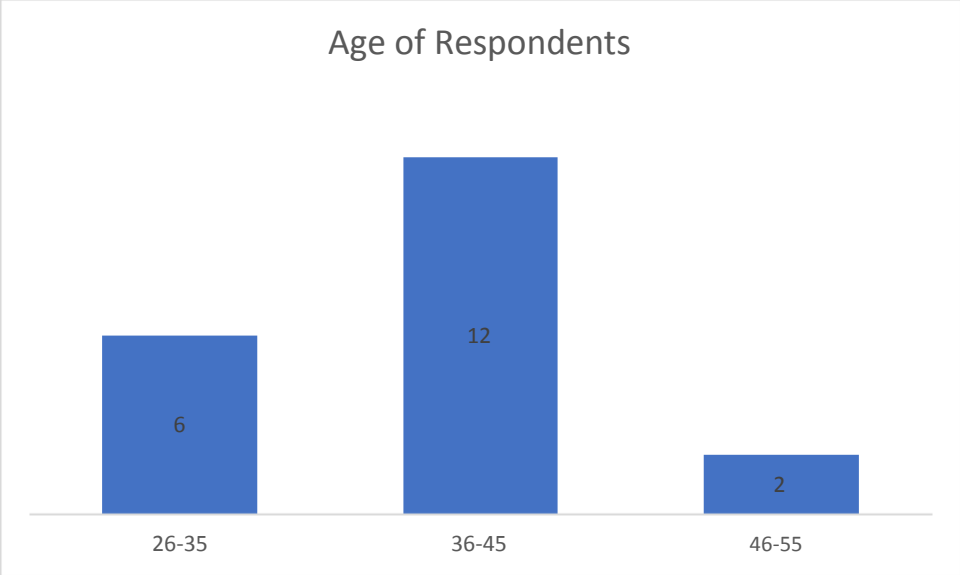


Figure 5: Age of Respondents

In this question five age categories were asked which were 18-25, 26-35, 36-45, 45-55 and 56 or above. The data depicted that participants belonged to three categories only and 12 out of 20, majority of them were from 36-45 range of age.

4.2.1.3 FACULTY OF RESPONDENT

This question helped to identify the faculty of respondents. BU has offered virtual labs of computing and networking programs under Faculty of Computing. This study has also included the participants of other faculties those are instructing computing courses for distance learning students. Therefore, following table and chart is depicting the ratio of participants across the faculties.

Table 3: Faculty of Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Faculty of Computing	19	95.0	95.0	95.0
	Faculty of Health and Education	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

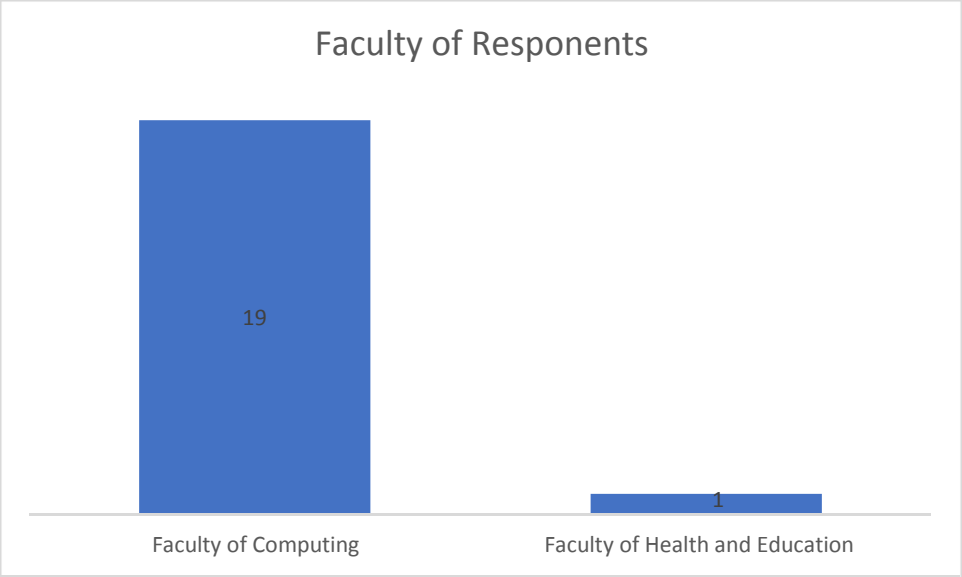


Figure 6 Faculty of Respondents

This data has shown that 19 out of 20 participants were from Faculty of Computer and only 1 was from Faculty of Health and Education, who is instructing DL computing students for their faculty.

4.2.1.4 DEPARTMENT NAME OF THE RESPONDENTS

The following table and figure provided the statistics on the participation of respondents from various departments under the same faculty.

Table 4: Respondents' Name of the Department

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Software Engineering	7	35.0	38.9	38.9
	Network and Infrastructure Management	8	40.0	44.4	83.3
	Web and Multimedia	1	5.0	5.6	88.9
	Blended & Distance Learning Campus	1	5.0	5.6	94.4
	Health Information Management	1	5.0	5.6	100.0
	Total	18	90.0	100.0	
Missing	99	2	10.0		
Total		20	100.0		

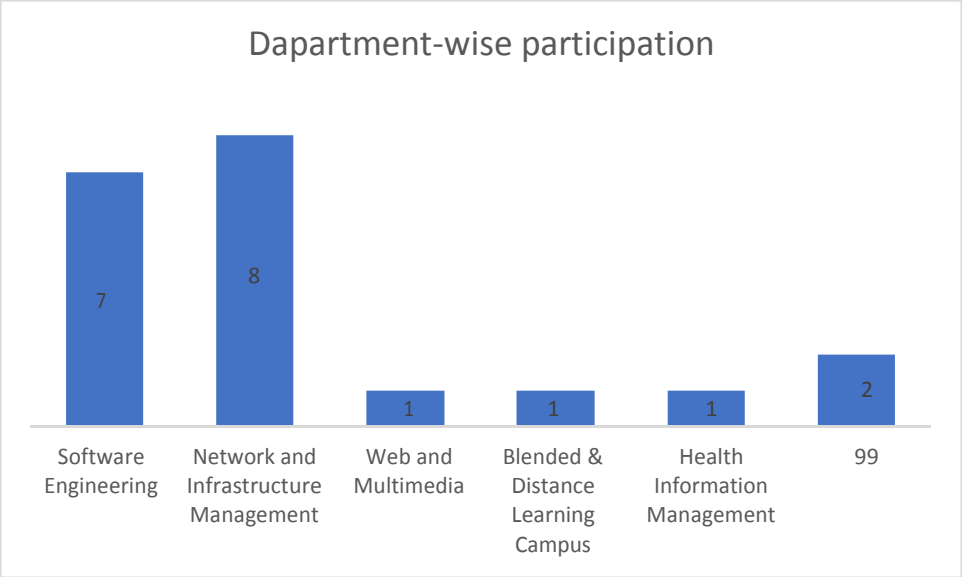


Figure 7: Respondents' Name of the Department

The above figure has depicted the ratio of participation from various departments under two faculties. Major participation was from Network and Infrastructure management and Software Engineering departments. Variable '99' in above chart indicated the missing value for the variable Name of the Department, which means two respondents did not specify their department name.

4.2.2 RESULTS OF RESEARCH OBJECTIVES

Questionnaire was used to evaluate three objectives of this study.

4.2.2.1 EVALUATE THE EFFECTIVENESS OF THE DESIGN OF VLABS DEVELOPED AND IMPLEMENTED BY BU.

The first objective of the study was to evaluate the design of the virtual labs developed and implemented by the Botho University. This section was designed to evaluate the components which are provided to students through virtual labs, to evaluate the sufficiency to cover the learning outcomes of the program. Therefore, lecturers' perspective on design of virtual labs were achieved with following questions.

4.2.2.1.1 VIRTUAL LABS ARE IMPERATIVE TOOL FOR ONLINE DISTANCE LEARNING STUDENTS

Table 5: Virtual labs are imperative eLearning tool for online distance learning students

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	5.0	5.0	5.0
	Agree	11	55.0	55.0	60.0
	Strongly Agree	8	40.0	40.0	100.0
	Total	20	100.0	100.0	

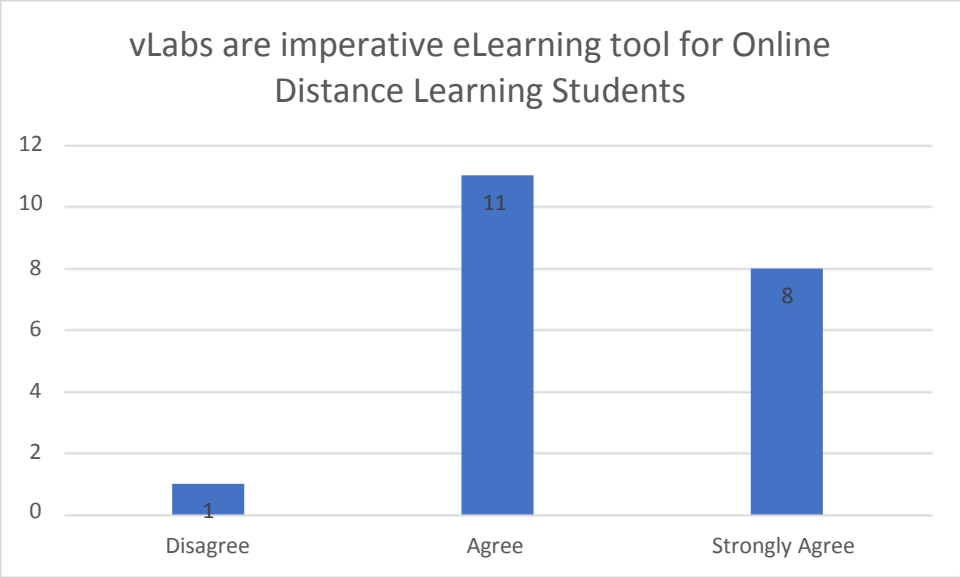


Figure 8: Virtual labs are imperative eLearning tool for online distance learning students

This graph has depicted that the 95% of respondents have accepted that the vlabs are imperative tool for online distance learning students. In the absence of real labs and lack of interaction with tutor, vlabs experiments plays important role to be alive in group through discussions and simulation experiments.

4.2.2.1.2 VIRTUAL ENVIRONMENT IS USER FRIENDLY

Table 6 Virtual Labs are user friendly

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	Disagree	5	25.0	25.0	25.0
	Agree	14	70.0	70.0	95.0
	Strongly Agree	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

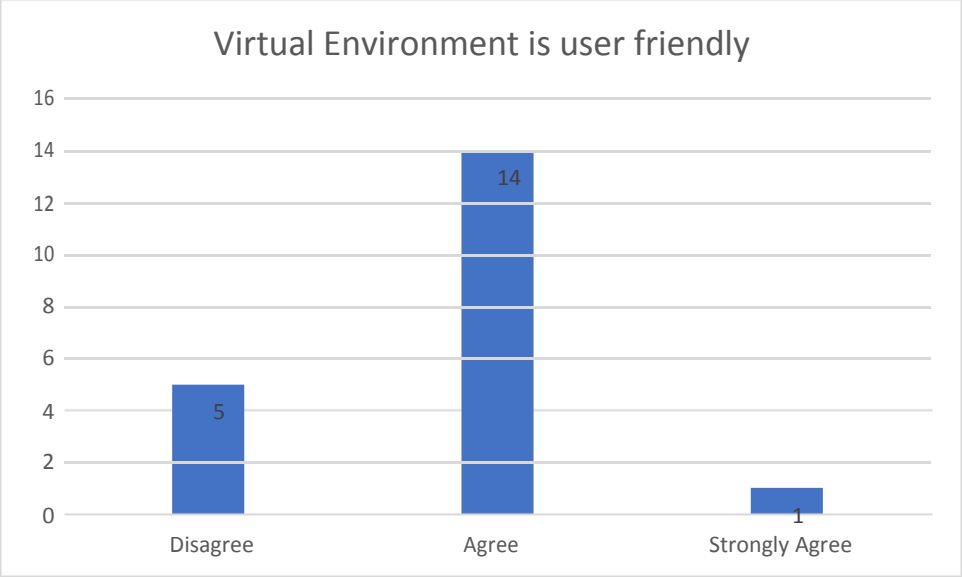


Figure 9: Virtual labs are user friendly

80% of respondents are agreed on that the vlab environment is user friendly, with basic understanding of computers anyone can access to the course material and even they can store the results of experiments for further discussions with their supervisors.

4.2.2.1.3 VLABS REQUIRED USER MANUALS FOR ITS USERS

Table 7: Virtual labs required user manuals

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	5.0	5.0	5.0
	Agree	9	45.0	45.0	50.0
	Strongly Agree	10	50.0	50.0	100.0
	Total	20	100.0	100.0	

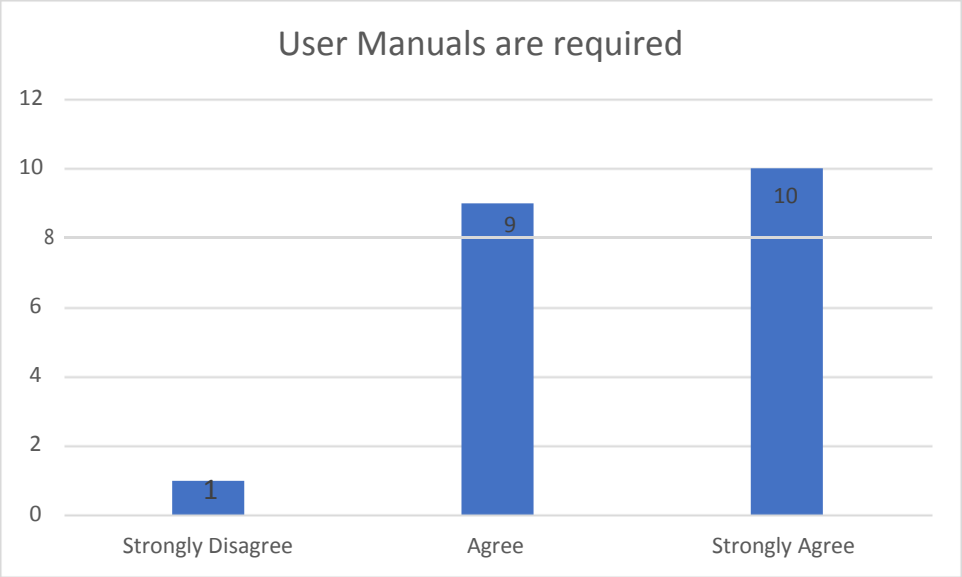


Figure 10: Virtual labs required user manuals

Findings have depicted that even though vlabs are user friendly, online distance learning students required user manuals. As the online distance learning students are from different background and culture, user manuals can help to enhance their experience on vlab and which will motivate them to actively participate in vlab activities. So, 95% of respondents are agreed that the self-explainer user manuals should be provided along with the well-structured training at the commencement of the semester.

4.2.2.1.4 REQUIRED COMPONENTS ARE AVAILABLE TO STUDENTS

Table 8: Availability of vLab components to students

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	9	45.0	45.0	45.0
	Agree	9	45.0	45.0	90.0
	Strongly Agree	2	10.0	10.0	100.0
	Total	20	100.0	100.0	

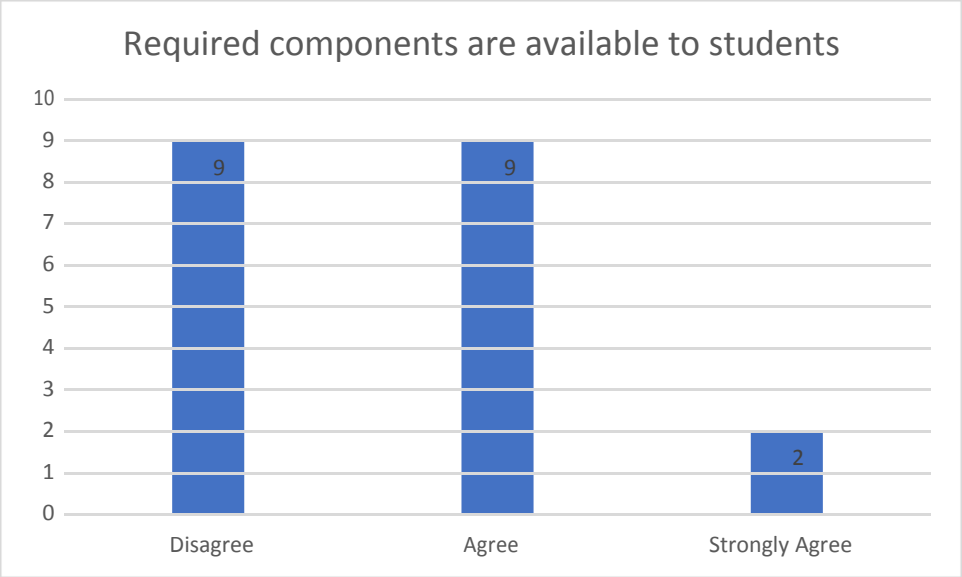


Figure 11: Availability of vLab components to students

55% of respondents have reported that all the required components to achieve learning outcomes are available on the vlabs whereas 45% are disagree with it.

4.2.2.1.5 VIRTUAL LABS ARE DESIGNED APPROPRIATELY TO SERVE LEARNING OUTCOMES OF THE PROGRAM

Table 9: vLab covers learning outcomes of the program

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	6	30.0	30.0	30.0
	Agree	12	60.0	60.0	90.0
	Strongly Agree	2	10.0	10.0	100.0
	Total	20	100.0	100.0	

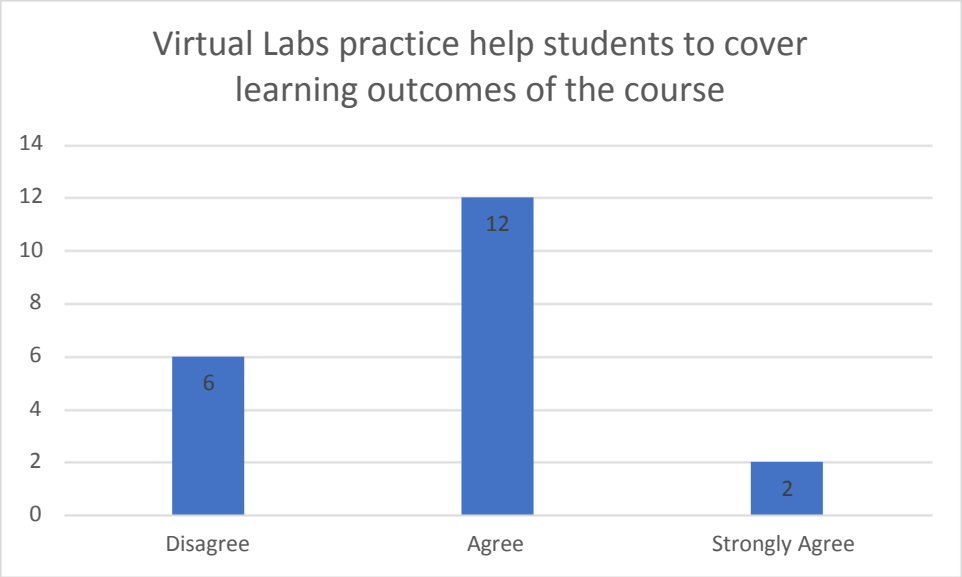


Figure 12: vLab covers learning outcomes of the program

70% of respondents have reported that virtual labs have components which can help students to achieve their learning outcomes. Virtual labs offer interactive tutorials and 3D experiments which can help students to achieve skills and knowledge for which the course is designed.

4.2.2.2 IDENTIFY THE CHALLENGES FACED BY STUDENTS IN USING VLABS

This section focused on the challenges faced by students in utilizing the components of virtual labs through lecturer's perception. This objective was evaluated with five question which covers the accessibility, scope, pre-requisites and ease-of-usage. Questions used to evaluate this objective are depicted through the following tables and results through stacked bar chart:

Table 10: Virtual labs helps to achieve the learning outcomes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	3	15.0	15.0	15.0
	Agree	13	65.0	65.0	80.0
	Strongly Agree	4	20.0	20.0	100.0
	Total	20	100.0	100.0	

Table 11: Virtual Labs are accessible 24x7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	6	30.0	30.0	30.0
	Agree	8	40.0	40.0	70.0
	Strongly Agree	6	30.0	30.0	100.0
	Total	20	100.0	100.0	

Table 12: Virtual Labs are accessible from anywhere

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	3	15.0	15.0	15.0
	Agree	12	60.0	60.0	75.0
	Strongly Agree	5	25.0	25.0	100.0
	Total	20	100.0	100.0	

Table 13: Students can do their assignments on vLabs without the help of instructor

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	5.0	5.0	5.0
	Disagree	4	20.0	20.0	25.0
	Agree	13	65.0	65.0	90.0
	Strongly Agree	2	10.0	10.0	100.0
	Total	20	100.0	100.0	

Table 14: Students from non-IT background, can also access virtual labs effectively

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	Strongly Disagree	2	10.0	10.0	10.0
	Disagree	9	45.0	45.0	55.0
	Agree	8	40.0	40.0	95.0
	Strongly Agree	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

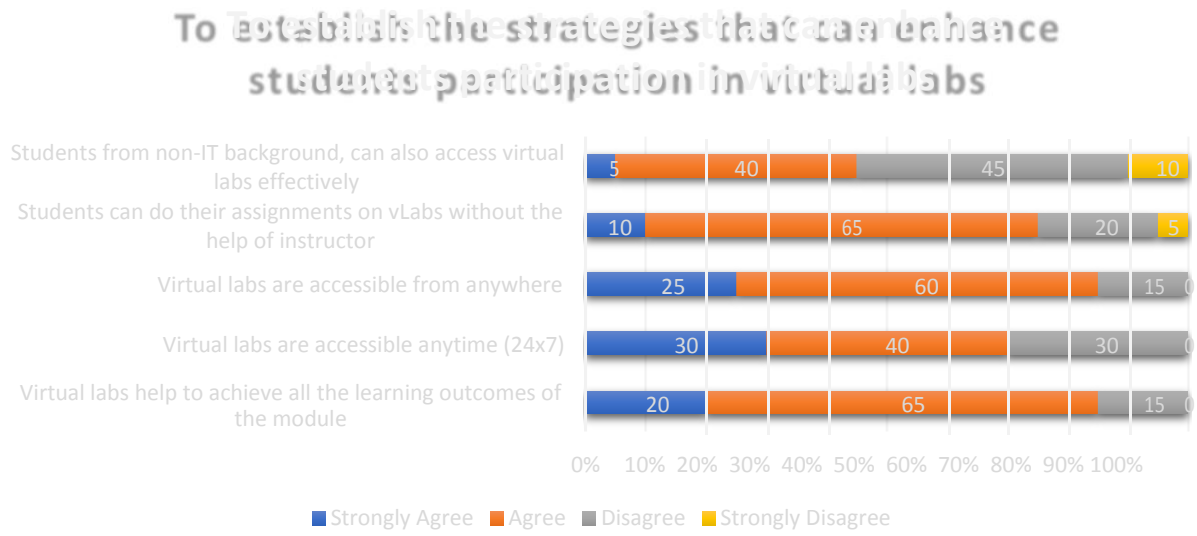


Figure 13: TO IDENTIFY THE CHALLENGES FACED BY STUDENTS IN USING VLABS

The major issue Botho University is facing that students are not participating actively in vlab activities. This section of questionnaire helps to identify the challenges students are facing in accessing virtual labs. Five questions were framed to achieve this objective.

Majority with 55% respondents have reported that the students with non-IT background faces challenges in practicing with virtual labs, even though the user manual were provided, students were finding it difficult to practice experiments with vlabs. 75% of respondents have reported that the students can work on their own, without any interference by tutors. 85% are agreed that the vlabs are accessible from anywhere like school, office, home etc. 70% of them are agreed that the vlabs are accessible at any time, but the bandwidth need to be high for better functionality and demonstration of virtual experiments.

4.2.2.3 MEASURE THE EFFECTIVENESS OF VLABS ON STUDENTS' LEARNING THROUGH LECTURER'S PERSPECTIVE

The purpose of this section was to measure the effectiveness of vLabs on students' learning through lecturers' perception. This section contains eight questions to understand how effectively vLabs enhance students' knowledge, skills and competencies. This objective of the study will help to understand if virtual labs motivates student learning and enhance independent learning skills and prepare them to work in global job-market. Questions to achieve this objective are depicted through following table and result is represented through the stacked bar chart:

Table 15: vLabs have positive impact on students' learning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	5.0	5.0	5.0
	Agree	13	65.0	65.0	70.0
	Strongly Agree	6	30.0	30.0	100.0
	Total	20	100.0	100.0	

Table 16: Students are enthusiastic and motivated to practice in vLabs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	7	35.0	35.0	35.0
	Agree	9	45.0	45.0	80.0
	Strongly Agree	4	20.0	20.0	100.0
	Total	20	100.0	100.0	

Table 17: Students actively participate in vLab activities and assignments

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	Strongly Disagree	3	15.0	15.0	15.0
	Disagree	8	40.0	40.0	55.0
	Agree	9	45.0	45.0	100.0
	Total	20	100.0	100.0	

Table 18: vLab affects students' performance and achievements

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	5	25.0	25.0	25.0
	Agree	13	65.0	65.0	90.0
	Strongly Agree	2	10.0	10.0	100.0
	Total	20	100.0	100.0	

Table 19: vLab activities improve students' independence learning skills

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	5.0	5.0	5.0
	Disagree	1	5.0	5.0	10.0
	Agree	11	55.0	55.0	65.0
	Strongly Agree	7	35.0	35.0	100.0
	Total	20	100.0	100.0	

Table 20: vLab improves students' academic performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	5.0	5.0	5.0
	Agree	15	75.0	75.0	80.0
	Strongly Agree	4	20.0	20.0	100.0

	Total	20	100.0	100.0	

Table 21: students can gain skills in vLabs as required by global labor markets

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	1	5.0	5.0	5.0
	Agree	13	65.0	65.0	70.0
	Strongly Agree	6	30.0	30.0	100.0
	Total	20	100.0	100.0	

Table 22: Virtual Labs are the future of Higher Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	2	10.0	10.0	10.0
	Agree	10	50.0	50.0	60.0
	Strongly Agree	8	40.0	40.0	100.0
	Total	20	100.0	100.0	

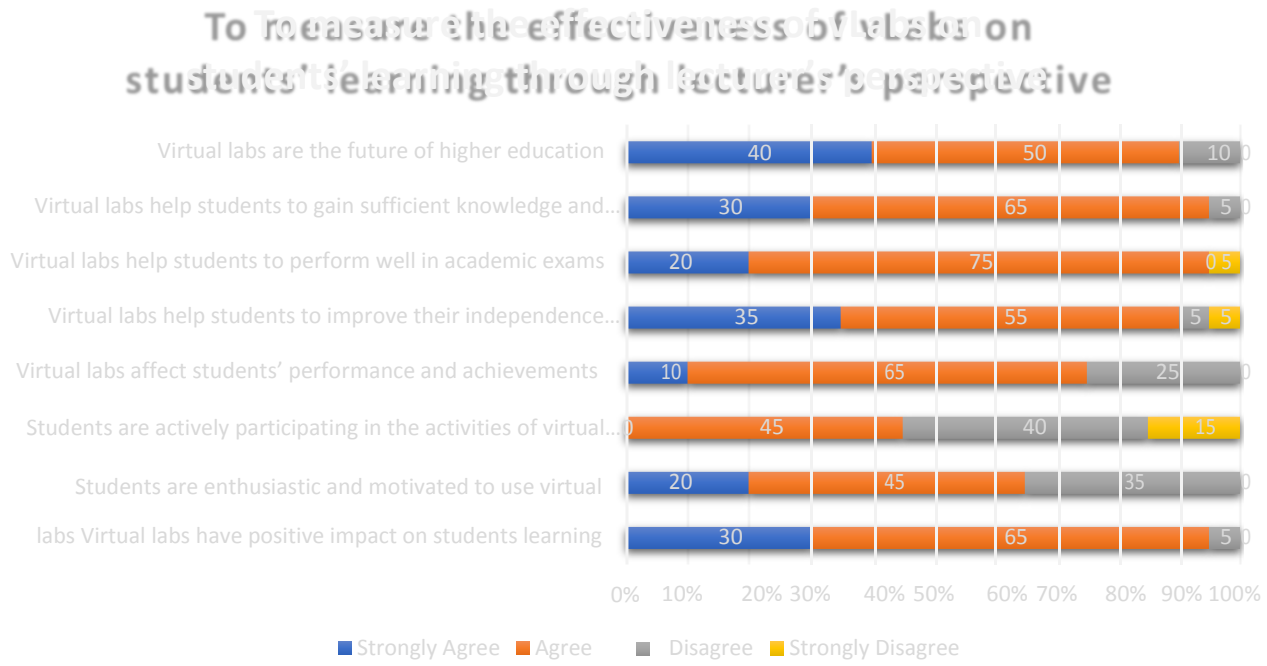


Figure 14: TO MEASURE THE EFFECTIVENESS OF VLABS ON STUDENTS' LEARNING

The purpose of this section was to evaluate the effectiveness and efficiency of virtual labs on students learning, for this purpose section was framed with eight questions. 90% of respondents are considering virtual labs the future for higher education institutions. 95% of respondents have agreed that students can gain sufficient knowledge and skills with vlabs simulations, as required by employers. Practicing with vlabs gives better experience than the real labs, vlabs help student to perform well in the academic exams. Virtual labs have truly positive impact on student's learning, performance and achievements.

Data has showed that the students are not actively participating in vlab activities and they are not enthusiastic and motivated towards to practice with vlabs.

4.2.3 RESULTS ANALYSIS ON RESPONDENTS' SUGGESTIONS

In this section of the questionnaire, respondents were asked to provide their suggestion to improvise the usage of virtual labs for computing program courses. Based on their responses, suggestions were categorized into four sub-sections which are i) upgrading the infrastructure and

design of vLabs; ii) upgrading the internet bandwidth; iii) training to staff and students and iv) make the usage of vLabs compulsory for students and staff.

Table 23: Upgrade infrastructure and design

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	10	50.0	71.4	71.4
	No	4	20.0	28.6	100.0
	Total	14	70.0	100.0	
Missing	99	6	30.0		
Total		20	100.0		

Table 24: Upgrade Internet Bandwidth

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	40.0	57.1	57.1
	No	6	30.0	42.9	100.0
	Total	14	70.0	100.0	
Missing	99	6	30.0		
Total		20	100.0		

Table 25: Training to staff and students

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	5	25.0	35.7	35.7
	No	9	45.0	64.3	100.0
	Total	14	70.0	100.0	
Missing	99	6	30.0		
Total		20	100.0		

Table 26: Make the virtual lab usage compulsory

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4	20.0	28.6	28.6

	No	10	50.0	71.4	100.0
	Total	14	70.0	100.0	
Missing	99	6	30.0		
Total		20	100.0		

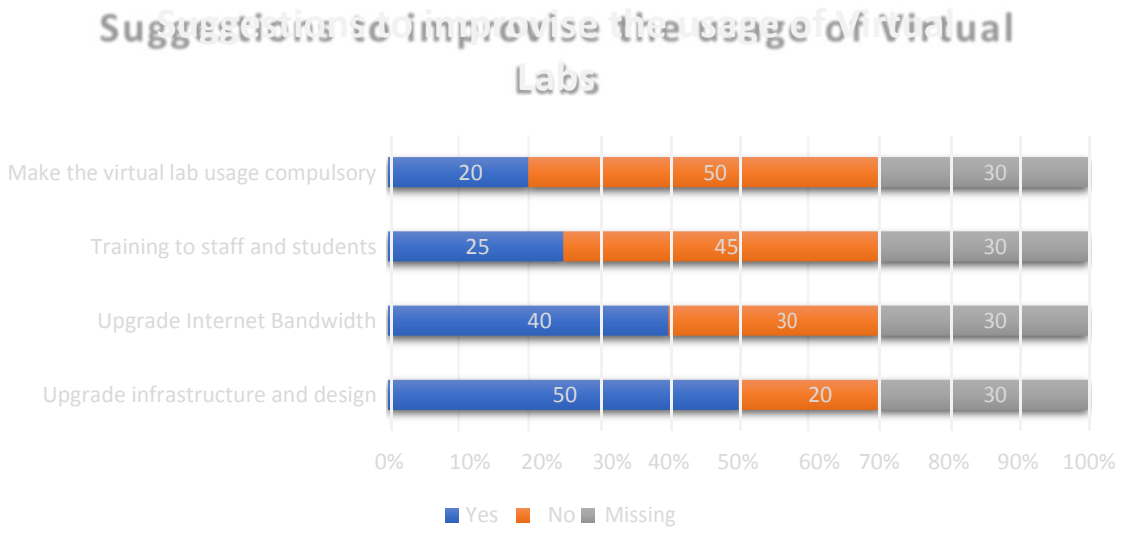


Figure 15: Suggestions to improvise the usage of virtual labs

Results of this study has depicted that virtual labs have positive impact on students learning and vlabs are the future of higher education institutions, but student are not enthusiastic and motivated to use vlabs and perform experiments. This section of the questionnaire was semi-structures part of the questionnaire, as it included open question for respondents to put their suggestions.

On the basis of suggestions, this section was divided into four categories. 50% of respondents said that there is the need to upgrade the infrastructure and the design of vlabs. 40% of respondents advised to improve the internet bandwidth for the better functionality of the components and better demonstration of the experiments. 25% of respondents also advised to organize trainings at the commencement of the semester along with the user manuals and if possible basic computing session for non-IT background students. 20% of the respondents recommended to include the usage of vlabs in assessments. They advised to conduct the exam on vlab to examine their skills and knowledge. This way the students will be forced to utilize vlabs.

4.3 SUMMARY

This chapter has presented the research findings in line with the research questions. Analysis of the results, findings, discussions, recommendations and conclusion of the study are presented in the next chapter.

CHAPTER 5 – FINDINGS AND DISCUSSIONS

5.1 INTRODUCTION

Chapter four has presented the results of collected data from questionnaire and interview. This chapter interprets the findings with reference to the research questions formulated in chapter one, the literature reviewed in chapter two and results analyzed in chapter four. The discussion of findings is classified into four sections states as follows which culminates in the development of conceptual framework of the successful model of virtual lab.

Lecturer's view on the design of the virtual lab which will help students to achieve their learning outcomes.

Lecturer's view on the accessibility of the virtual lab components which helps students to access vLab from anywhere and anytime at their convenient, which motivated them for independent learning.

Lecturer's view on the efficiency which will evaluate the knowledge, skills and competencies students are gaining from practicing in virtual labs.

5.2 INFLUENCE OF BIOGRAPHICAL INFORMATION ON IMPLEMENTATION OF VIRTUAL LABS

Biographical information helps in understanding the nature of the respondents. This study has showed that 95% of respondents were from Faculty of Computing, most of them were from the age range of 36-45 and 70% of male participated in this study.

5.2 LECTURER'S VIEW ON THE DESIGN OF VIRTUAL LABS

This study showed that the virtual labs implemented by Botho University are adequately designed. Sufficient components and resources are provided to staff and students which helps them to utilize them appropriately. 95% of Respondents has stated that the required user manuals were provided to the students. 75% of respondents has said that VLE environment is user friendly and together with user manuals, it is easy to utilize all the components as per the program need. Experiments in virtual labs also help students to achieve all the learning outcomes of the course.

The software which is used for virtual labs and the components provided are adequately appropriate for the online distance learning students of Botho University. All the required manuals are also provided to their students.

5.3 LECTURER'S VIEW ON THE ACCESSIBILITY OF VIRTUAL LABS

Virtual environment is user friendly, it is easy to work in virtual labs. This study has shown conflicting data on the usage of virtual labs for non-IT background students, 45% of respondents had mentioned that without any IT knowledge also students can access vLabs efficiently, whereas 55% of respondents have claimed that they required basic computer knowledge together with training will help students to utilize the components efficiently.

75% of respondents have claimed that students can do their assignments without the help of instructor and also can achieve all the learning outcomes of the course. Majority of the respondents have stated that the virtual labs are available anytime (24x7) and are accessible from anywhere, which can help online distance learning student to access education on their convenient time and place.

The biggest challenge faced by staff and students is the internet speed. Lecturers have suggested to upgrade the internet bandwidth which will help to utilize the virtual labs efficiently. Lecturers who participated in this study, and literature has also suggested the need to provide training to staff and students.

5.4 LECTURER'S VIEW ON THE EFFICIENCY OF VIRTUAL LABS

This study has showed that the implementation of virtual labs has positive impact on students learning. 95% of respondents are agreed on that practicing experiments in virtual labs can help students to perform well in academic exams and helps to gain sufficient knowledge and practical skills to work in global job-market. 90% of respondents have also admitted that the virtual labs are the future of higher education, as it also helps to enhance their independent learning skills. Students are enthusiastic and motivated to use vLabs but they are not actively participating virtual labs.

This study showed that virtual labs have highly positive impact on students learning and affects students' academic performance and achievements.

5.5 EVALUATION ON SUGGESTIONS OF RESPONDENTS

In this study, suggestions provided by respondents were categorized into four parts where they suggested to upgrade the internet bandwidth and make the usage of virtual labs compulsory for all the students which will help to enhance the students' participation. Respondents also suggested to include vLabs in assessment process to conduct formative and summative assignments. This study also suggested to provide training and continuous support to staff and students before semester start, which will motivate them and help them to utilize all the components efficiently.

5.6 SUMMARY OF CHAPTER-1

Chapter one introduced the study and stated the problem faced in efficiently implementing virtual labs and motivating students in actively participating and utilizing virtual labs for practical computing courses. This chapter also discussed the research questions and objectives, in regard to which conceptual framework was proposed to implement virtual labs effectively and enhance its productivity.

5.7 SUMMARY OF CHAPTER-2

Chapter two, as the part of literature review, the concept and history of eLearning and virtual labs were discussed. It was discussed that vLabs always have positive impact on students' learning and helps them to experiments safely and with low cost. It also helps learners to achieve knowledge, skills and competencies as required by global job-market.

5.8 SUMMARY OF CHAPTER-3

Chapter three discuss the research design and process of this study. It also highlighted the instruments used and population of the study. The SPSS version 21 was used to analyze the collected data. Validity, reliability and ethical consideration were also discussed in this chapter.

Chapter four represents the collected data in line with research objectives. Chapter five discussed the findings of the study. In this chapter, findings were concluded to answer the research questions and recommendations were presented.

5.9 CONCLUSION

The findings of this study show that the virtual labs are designed and implemented appropriately by Botho University but are not utilized by students appropriately. The findings have suggested that there is a need to make the usage mandatory and include virtual labs in conducting assignments which will enhance students' participation. In regard to, the research objectives, this study also offers the framework which will help to efficiently design, develop and implement the virtual labs and enrich its users' experience.

The discussion of findings also showed that major challenges that students faced in proper utilization of virtual labs are internet speed and lack of guidance. Upgraded internet speed, proper timely trainings and mandatory incorporation of virtual labs in curriculum will help to overcome these challenges.

This section of the chapter summarizes the study by drawing the conclusion about the effective implementation of virtual labs for online distance learning students. This chapter further make recommendation to enhance students' experience and participation in utilizing virtual labs. This study has been divided into five chapters.

Conclusions of this study are based on answers to the four research questions as shown below:

5.9.1 WHAT ARE THE COMPONENTS OF EFFECTIVE VLABS?

The findings of this study have concluded that the design of virtual labs plays crucial role for its successful and effective implementation. Appropriate selection of software for virtual lab, user manuals and trainings are imperative components of vLabs. Simulations, tutorial and contents uploaded on virtual labs also makes its implementation successful as it will help to achieve the learning outcomes of the course.

5.9.2 WHAT ARE THE CHALLENGES FACED BY STUDENTS IN USING VLABS?

Major challenges faced by students are the low speed of internet and lack of guidance. Due to poor internet speed, students fail to utilize the virtual labs components and perform the simulations and experiments. Students were also not provided with the trainings for proper utilization of its services.

5.9.3 WHAT ARE THE IMPACTS OF VLABS ON STUDENT'S PERFORMANCE?

Findings of this study have concluded that the practicing with virtual labs have positive impact on students learning. Literature has also proved that virtual labs have enhance the students' performance in academic exams and help them gaining knowledge, skills and competencies to better serves in global job-market. Virtual labs are the future of higher education.

5.9.4 WHAT ARE THE STRATEGIES TO BE EMPLOYED FOR EFFECTIVE IMPLEMENTATION OF VLABS?

This study has proposed the framework to effectively implement vLabs for online distance learning students. These strategized frameworks is provided in chapter one which is categorized into four parts: virtual environment, services and support, accessibility of components and user role. Virtual environment is consisting of selection of software to design and develop vLabs and components available to users to achieve objectives. Services and support is consisting of simulation programs, 3D animated experiments, interactive tutorials and instructors' motivation and support helps learners to utilize its components at ease. Accessibility includes technical support and high internet bandwidth will assist in smooth functionality of vLabs. Last but not the least user role also performs important role in effective implementation of vLabs. students are supposed to be enthusiastic and motivated to actively participative in experiments and peer discussions over vlabs. All these factors together will help to effectively and efficiently implement vLabs and enrich its user's experience.

5.10 RECOMMENDATIONS

Based on the findings and conclusions of this study, the following recommendations are made:

Institution should also invest to provide proper training to its staff and students for proper utilization of its components.

Educators should incorporate virtual labs in conducting assessments, and make its usage mandatory for its participates.

Due to positive impact of virtual labs, this study recommend to implement virtual labs for other online distance learning program, with the appropriate selection of vLab softwares.

This study will also recommend to investigate and compare the practical skills gained by students in virtual labs with the skills gained by students in real traditional labs.

Due to lack of time, this study was conducted only in one of the higher education institution of Botswana, the author recommends conducting similar study in other HEIs of the country. Another limitation of this study was the small sample size, only lecturers were included in the study, because students were not using and participating in virtual labs activities. There is the need to continue this line of research with the large sample and with other HEIs of the country.

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APPENDIX A: DISSERTATION QUESTIONNAIRE FOR LECTURERS

DISSERTATION QUESTIONNAIRE FOR LECTURERS –

by RAMANDEEP KAUR

DISCLAIMER

The questionnaire below is part of the M. Ed. (Higher Education) study to evaluate the effectiveness of the virtual laboratories implemented by Botho University for online distance learning students. This research is being conducted under the supervision of Dr. Jane Iloanya.

The aim of the study is to investigate student's experience in using virtual Labs. Your unbiased responses will help us to improve the quality of virtual labs offered by universities during bachelor degrees programs. Results of this study will help to understand, if the students are gaining same knowledge, skills and competencies, as required by real-time workplaces and to institution to implement effectively to enhance staff and students' experience. The results of this study will be used by researcher for research based activities only. We respect your privacy, so your responses and identity are anonymous. Please feel free to contact me on my email raman.kaur@bothouniversity.ac.bw, for any further clarification on research.

INSTRUCTIONS

You are kindly requested to take 15 minutes of your time to complete the questionnaire by putting a tick (✓) in the appropriate box bearing your response, using the scale below, the extend of agreement with following statements. Your responses will be treated in utmost confidence.

(4 – Strongly Agree, 3 – Agree, 2 – Disagree, 1 – Strongly Disagree)

A. Biographical Information

Gender	○ Male ○ Female
Age	○ 18-25 ○ 26-35 ○ 36-45 ○ 46-55 ○ 56 or above
Faculty	○ Faculty of Business and Accounting ○ Faculty of Computing ○ Faculty of Engineering and Applied Sciences ○ Faculty of Health and Education ○ Faculty of Hospitality and Sustainable Tourism
Name of the Department	

B. Lecturers perception towards students experience in Virtual Labs

RO1	**TO EVALUATE THE EFFECTIVENESS OF THE DESIGN OF VLABS.**				
No.	**Perceptions**	**Strongly Agree (4)**	**Agree (3)**	**Disagree (2)**	**Strongly Disagree (1)**
1	Virtual labs are imperative tools for online distance learning students				
2	Environment of virtual labs is user friendly				

3	Virtual labs required user manual for its users				
4	All the required components are available to the students				
5	Virtual labs are designed appropriately as per the needs of the module				

RO2	**TO IDENTIFY THE CHALLENGES FACED BY STUDENTS IN USING VLABS**				
No.	**Perceptions**	**Strongly Agree (4)**	**Agree (3)**	**Disagree (2)**	**Strongly Disagree (1)**
6	Virtual labs help to achieve all the learning outcomes of the module				
7	Virtual labs are accessible anytime (24x7)				
8	Virtual labs are accessible from anywhere				
9	Students can do their assignments on vLabs without the help of instructor				
10	Students from non-IT background, can also access virtual labs effectively				

RO3	TO MEASURE THE EFFECTIVENESS OF VLABS ON STUDENTS' LEARNING				
No.	**Perceptions**	**Strongly Agree (4)**	**Agree (3)**	**Disagree (2)**	**Strongly Disagree (1)**
11	Virtual labs have positive impact on students learning				
12	Students are enthusiastic and motivated to use virtual labs				
13	Students are actively participating in the activities of virtual lab				
14	Virtual labs affect students' performance and achievements				
15	Virtual labs help students to improve their independence learning skills				
16	Virtual labs help students to perform well in academic exams				
17	Virtual labs help students to gain sufficient knowledge and skills to work in global labor market				
18	Virtual labs are the future of higher education				

C. Suggestions: Areas to improve

Comment……

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Thank You.

APPENDIX B: DISSERTATION INTERVIEW QUESTIONS FOR LECTURERS AND TECHNICAL TEAM

Interview Guide

DISSERTATION QUESTIONNAIRE FOR LECTURERS –

by RAMANDEEP KAUR

DISCLAIMER

The questionnaire below is part of the M. Ed. (Higher Education) study to evaluate the effectiveness of the virtual laboratories implemented by Botho University for online distance learning students. This research is being conducted under the supervision of Dr. Jane Iloanya.

The aim of the study is to investigate student's experience in using virtual Labs. Your unbiased responses will help us to improve the quality of virtual labs offered by universities during bachelor degrees programs. Results of this study will help to understand, if the students are gaining same knowledge, skills and competencies, as required by real-time workplaces and to institution to implement effectively to enhance staff and students' experience. The results of this study will be used by researcher for research based activities only. We respect your privacy, so your responses and identity are anonymous. Please feel free to contact me on my email raman.kaur@bothouniversity.ac.bw, for any further clarification on research.

INSTRUCTIONS

You are kindly requested to take 15 minutes of your time to complete the questionnaire by putting a tick (✓) in the appropriate box bearing your response. Your responses will be treated in utmost confidence. Using the scale below, the extend of agreement with following statements.

(5 – Strongly Agree, 4 – Agree, 3 – Neutral, 2 – Disagree, 1 – Strongly Disagree)

BIOGRAPHICAL INFORMATION

Gender	○ Male ○ Female
Age	○ 18-25 ○ 26-35 ○ 36-45 ○ 46-55 ○ 56 or above
Faculty	○ Faculty of Business and Accounting ○ Faculty of Computing ○ Faculty of Engineering and Applied Sciences ○ Faculty of Health and Education ○ Faculty of Hospitality and Sustainable Tourism
Name of the Department	

<u>Interview Questions</u>

Design of Virtual Labs

Q. Do you think virtual labs are designed appropriately as per the needs of the module and it covers all the leaning outcomes of the module?

Q. Do you think virtual environment is user friendly?

Q. Did you provide any user manual?

Q. Do you think students can work without the help of instructors or do they need user manuals for proper utilization of the virtual labs?

Accessibility of Virtual Laboratories

Q. How frequently do you upload activities and assignments on virtual labs?

Q. Are students enthusiastic and motivated towards the usage of virtual labs, do they actively participate in the activities and assignments on virtual labs?

Q. What do you think about the accessibility of the virtual labs, is it available anywhere and anytime (24x7), or is there any technical issue associated with the usage of virtual labs?

Effectiveness of Virtual labs on students' performance

Q. Do you think virtual labs have any impact on students' learning, positive or negative? Why?

Q. Do you think after practicing in virtual labs, students are prepared well to write their assignment in real/traditional labs? Do virtual labs have positive or negative impact on students' performance, attitude and achievements?

Benefits and Challenges

Q. Could you briefly explain the benefits and challenges associated with the usage of virtual labs for undergraduate students?

Areas to Improve

Q. Is there any aspect of virtual labs that needs to be improved? Which and why?

Q. Have you benchmarked virtual labs of BU against other institutions?

APPENDIX C: CONSENT FORM FOR INTERVIEWEES

CONSENT FORM – M. Ed. DISSERTATION RESEARCH

Title of Research: "***The Effectiveness of Virtual Labs in Higher Education Institutions of Botswana:***

A Case Study of Botho University"

Researcher: Ramandeep Kaur

Supervisor: Dr. Jane Iloanya

I confirm that I have understood the purpose of research and have had the opportunity to clarify my concerns. ☐

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reasons. ☐

I agree to take part in the above study. ☐

_____	_____	_____
Name of the participant	Date	Signature

APPENDIX D: RESEARCH PERMIT

TELEPHONE: 3655400/3655483
TELEX: 2944 THUTO BD
FAX: 3914271

REPUBLIC OF BOTSWANA

MINISTRY OF TERTIARY EDUCATION,
RESEARCH,SCIENCE AND TECHNOLOGY
PRIVATE BAG 00517
GABORONE

REF: MOTE 1/18/6 V (53)

22nd December 2017

Mr. Ramandeep Kaur
P O Box 501564
Gaborone

Dear Sir/Madam

Re: The Effectiveness of Virtual Labs in Higher Education Institutions of Botswana: A Case Study of Botho University

Reference is made to your application on the above captioned matter.

Your application for Research Permit for the proposed research tilted '**The Effectiveness of Virtual Labs in Higher Education Institutions of Botswana: A Case Study of Botho University.**' has been granted. The permit is valid for one (1) year. You are kindly advised to peruse section 4.4 to 5.0 of the 'Guidelines for Application for Research Permit' in Botswana.

Any changes in the proposed research should be communicated, without fail, to the Permanent Secretary, Ministry of Tertiary Education Research Science and Technology citing above reference.

By copy of this letter, the Director of Research Science and Technology is advised to take note of this development and ensure that deliverables to government are timely met.

Yours faithfully

Oupa T. Masesane
Acting Permanent Secretary

cc: Director of Research Science and Technology

TOLL FREE:0800-600-185
PRIVATE BAG 00517
GABORONE

APPENDIX E: RESEARCH PERMISSION LETTER FROM BOTHO UNIVERSITY

GABORONE:
Botho Education Park, Kgale
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BOTHO UNIVERSITY
EXCELLENCE | LEADERSHIP | INNOVATION

Ref: 0644/GSERC/GB/2017
November 28, 2017

The Permanent Secretary
Ministry of Tertiary Education, Research Science & Technology
Private Bag 00517
Gaborone

Dear Sir/Madam

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

This is to confirm that Ms Ramandeep Kaur is a student of Botho University reading for a Masters of Education in Higher Education programme.

The student would like to conduct research at Botho University under the topic **"The Effectiveness of Virtual Labs in Higher Education Institutions of Botswana: A Case Study of Botho University"**

In light of the above, the Department of Graduate Studies in Education, Research and Consultancy in Botho University is seeking your permission to allow her to carry out this research and accord her the necessary support as it will help in the completion of her studies.

The information collected will be used solely for this research and will be treated with high confidentiality.

Yours faithfully

Dr. Norman Rudhumbu (PhD)
Assistant Dean Faculty of Graduate Studies and Research
Botho University - Gaborone Campus
Tel: +267 3635494
Cell 72558689/73055062
E-mail: norman.rudhumbu@bothouniversity.ac.bw

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