

Study on the Usability of GNS3 for Teaching and Learning System and Network Administration

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Abstract

System and network administration training requires intensive hands-on practice. However, due to a large number of students in a classroom, giving access to real physical servers and networking devices to the individual students is not feasible and unrealistic. Instead, simulation-based teaching is used as an alternative. This study was intended to assess the students' satisfaction and the limitations associated with the teaching and learning of System and Network Administration in a simulated virtual network among the diploma in Computer System and Network students of Jigme Namgyel Engineering College, 2017. This cross-sectional study was conducted among the second year Computer Hardware and Networking students. A total of 44 students participated in this study of which 67.6% agreed that system and network administration can be infact taught and learned in the virtual network using GNS3 as opposed to using the real physical equipment, while 13.5% of the participants were undecided. 54% of the students felt that they had either a good or an excellent learning experience using GNS3, while 37.8% had experienced an average learning experience. It was found that using the real physical equipment in the teaching and learning was desired but in the cases of budget constraints, GNS3 could be used as well as a supplementary tool to meet the learning outcomes in case of the resource constraints.

Keywords: Effectiveness, GNS3, Network Administration, System Administration, Virtual Network

I. INTRODUCTION

The Diploma in Computer Hardware and Networking is a two-year program. This course is industry relevant, and hands-on labs are the essential parts for the subjects such as System Administration and Networking. For the previous batches, system and network administration concepts were taught in the laboratory using physical networking equipment and systems. However, because of the limited equipment owing to the cost and limited space, repeating lab sessions were necessary.

In a small sized classroom, the conventional method of teaching system and network administration can be used, which involves the use of the real TCP/IP based network consisting of physical servers and the networking devices such as routers and switches whereby the students get to practice on the near-to-real network with the real physical equipment. This is an ideal laboratory expected to be provided to the students for acquiring the knowledge and skills required for server and network administration before they even start their career.

However, due to a large number of students appearing for the same course, assigning real physical servers and networking devices to the individual students becomes very difficult owing to the involvement of huge financial cost and the risk of devices being mishandled.

In order to ease the financial implication and at the same time aiming to help all the students get hands-on practice, the system and network administration practical lessons were conducted in a simulated network environment with the help of Graphical Network Simulator (GNS3) to emulate the devices such as servers, switches, routers, etc.

According to (Chan, 2015) the integration of the GNS3 with the existing Cisco physical equipment and the redesigned laboratory exercises increased the laboratory capacity significantly thereby enabling the students to carry out the experiments either by being in the laboratory or remotely from their homes ultimately fulfilling the University's strategic plan of modernizing the delivery of hands-on networking labs.

It is noted that teaching and learning competencies at the university are challenging for students and lecturers and simulations are seen as a promising way to achieve the goal (Bell, Kanar, & Kozlowski, 2008).

In a survey conducted by Ghorbani et al (2016) on the use of GNS3 for virtualizing the computer networks, it was noted that GNS3 was used as an alternative tool which allows the professionals to implement, validate, test and verify new networking protocols and algorithms in a cost-effective manner. Besides GNS3 they have also found simulators such as Network Simulator 2 (NS2), Network Simulator 3 (NS3), Optimized Network Engineering Tools (OPNET), Optical Micro-Networks Plus (OMNET++), Network-Based Simulation and Modeling Environment (NETSIM), Realistic and Large (REAL), Java-based Simulation (J-SIM) and QUALNET were available. In which some were commercial in nature. The GNS3 is a free tool which allows simulating complex networks by virtualizing the real networking devices such as routers, switches, and servers.

In a study conducted based on the opinions of the students and the assessment on the comprehension of the topics, it showed that the students comprehended the basic topics just like the way they are taught in a real computer network laboratory. However,

some of the limitations such as the inability of the GNS3 to simulate some of the protocols such as Token Ring or WiFi (IEEE 802.5 – 802.11) were encountered (Gil, et al., 2014).

Fogarty, S. (2015) perceived that GNS3 is an ideal network emulation tool as it allowed the complete configuration of the network devices such as routers. The GNS3 is not only used for teaching networking courses; even carrying out the case studies of a compromised website by a SQL-Injection attack was carried out by Al-Mahrouqi et al (2015) using the open source tools such as GNS3, Oracle VirtualBox, and VMWare Workstation.

Simulation-based training encompasses a continuum of technology intended for training purposes. Simulation, in general, is an artificial or synthetic environment that is created to manage an individual's (or team's) experiences with reality (Bell, Kanar, & Kozlowski, 2008).

Lampi (2013) states that there was evidence of students showing performance gains both while using the virtual as well as the real labs by comparing their pre-test and post-test results. Also, the results showed that the use of virtual labs contributed positively to the transfer of practical computer networking skills from the virtual to the real lab environment.

Thus this current study aimed to assess the students' level of satisfaction and their learning experiences using the GNS3 so that the way things are taught can be changed if there be a need. This study was primarily guided by the following questions:

- How satisfied are the students with the experience of learning system administration in the simulated and emulated environment?
- Are the students confident to administer the real physical systems after learning in the simulated network?
- What are the constraints faced while using the GNS3?

II. METHODS

A cross-sectional study was conducted from November 13, 2017, to November 20, 2017, in the Department of Information Technology using the Online Classroom and the Simulation Laboratory.

The source of the population was diploma in Computer System and Network students studying at Jigme Namgyel Engineering College which included all the diploma in Computer Hardware and Networking students who attended System and Network Administration module.

A structured questionnaire which contained variables on the usability of GNS3 software for teaching and learning of the system and network administration was used for collecting the data. All the collected data were checked individually for the completeness and consistency, and then the data was analyzed.

Prior to the data collection, participants were informed about the purpose and objective of the study and they also informed of their rights to refuse to participate. In addition, the participants' consent was obtained verbally and the confidentiality and privacy of the data collected were maintained.

III. RESULTS

A. Demographic Characteristics of the Study Participants:

A total of 37 students responded in the study making a response rate 84.09%. Among the respondents of this study, 45.90% were male while 54.10% were female.

B. Students' Perception on the Usability of GNS3:

A majority of the participants (67.6%) perceived that the GNS3 software was either "Easy to use" or "Very easy to use" for teaching and learning purpose.

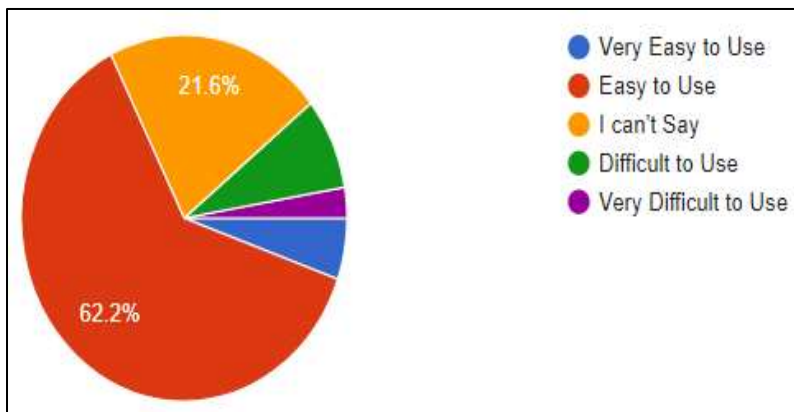


Fig. 1: Students' perception on the usability of GNS3

C. Understanding of the System and Network Administration:

Over half (50.30%) of the respondents had the opinion that they were able to understand the concepts of system and network administration taught in the virtual network using the GNS3, while 32.40% were not sure.

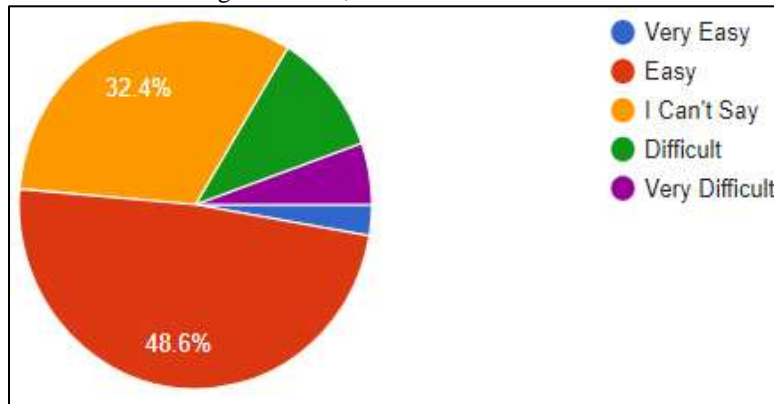


Fig. 2: Students' perception on the understanding of the concepts

D. Confidence in Configuring Servers and Network:

A total of 51.40% of the participants felt that they were confident enough to configure the servers and network virtually with 37.80% of the participants remaining unsure. However, the majority of the participants (91.90%) were either unsure or felt not confident enough to configure servers and network using the real physical systems.

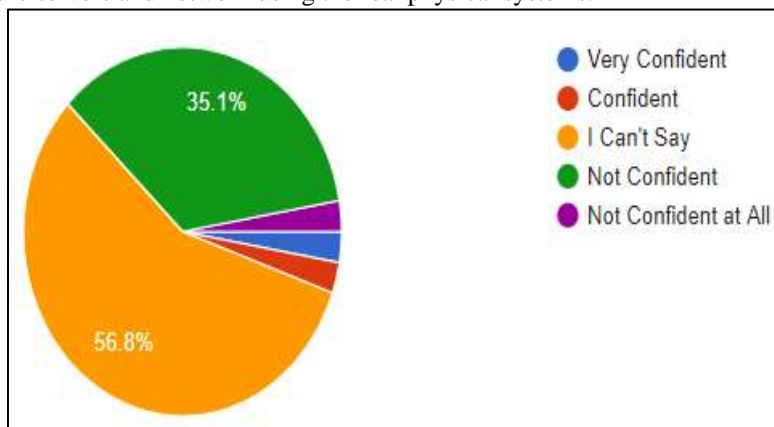


Fig. 3: Confidence in configuring servers and network

E. GNS3 as Alternate Resource:

A considerable percentage (67.60%) of the respondents are of the opinion that GNS3 can be used for teaching system and network administration as an alternative to real physical devices.

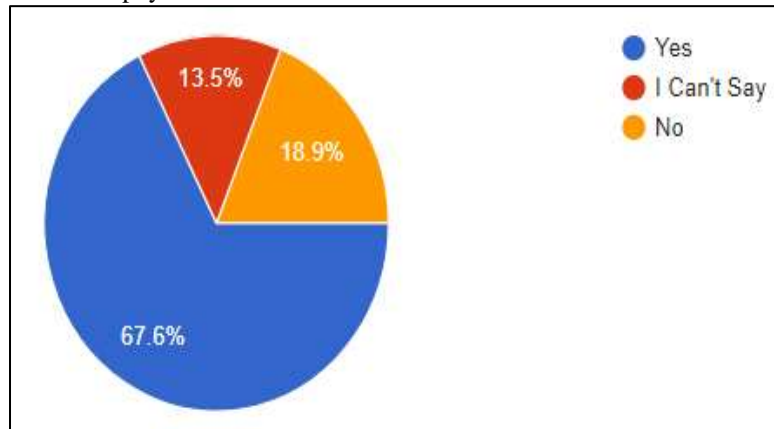


Fig. 5: students' opinion on the usability of GNS3 as the alternate resource

IV. DISCUSSION

The purpose of the study was to assess and evaluate the possibility of using the GNS3 software for simulating and emulating the network and devices for teaching the system and network administration to impart the knowledge and skills required by the administrators of the systems and network. In this study, based on the respondents, the majority of the participants (67.6%) agreed that GNS3 software was either “Easy to use” or “Very easy to use” for teaching and learning purpose. A total 50.30% respondents felt that the concepts of system and network administration taught using the GNS3 software in the virtual network was either easily or very easily understood.

Although more than half of the respondents felt that they are confident in simulating a functional network consisting of servers and devices using GNS3, the majoring of the respondents had reservations or felt not confident enough to face and configure the real physical network and systems. However, in contrast, there is a strong feeling among the respondents regarding the possibility of using the open source GNS3 as an alternative tool to teach the concepts and skills of system and network administration in the absence of real physical equipment.

One of the limitations spotted while using the GNS3 as a virtual lab was the system becoming non-responsive after running multiple virtual machines due to the limited RAM and the processing speed of the desktop computers in the laboratory.

V. CONCLUSION AND RECOMMENDATION

The level of students’ satisfaction based on their experience of using GNS3 to learn concepts and skills for system and network administration in a simulated environment was found to be moderate. However, their confidence in applying the concepts and skills in the real physical devices was found to be very low.

The use of GNS3 for teaching and learning the concepts and skills of system and network administration is recommended as a supplementary tool, not as a substitute for the real physical devices and systems. It is also advised that the computers in the laboratories be replaced or upgraded to the recommended hardware requirements in order to avoid systems becoming non-responsive and 100% CPU utilization if GNS3 is being used for teaching and learning.

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