

Learning Computer Networking Using Virtualization Tools

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ABSTRACT

In this paper, we have tried to fill up the gap that we found in related research work that primarily focusses on the use of various virtualization tools, their advantages and challenges from an organizational and management perspective. We developed a questionnaire to collect data from the students of various age groups doing various levels of computer networking courses. Views of students were collected about whether the virtualization has helped them in developing necessary skills and learning of the computer networking concepts or not or up to what level these virtualization tools are helpful. Our objective was to address the student's point of view towards learning networking courses using virtualization tools. In this paper we have identified that the virtualization tools have greatly helped students in learning computer networking concepts, the students who had just finished high school, found virtualization very interesting and helpful in learning networking however the students who had completed bachelor degrees or had some networking experience were not as satisfied.

Categories and Subject Descriptors

C.2.1 [Computer Communication Networks]: Network Architecture and Design - *Network communications, Network topology*; C.2.2 : Network Protocols - *Protocol architecture, Routing protocols*; C.2.3 : Network Operations - *Network management, Network monitoring*; K.3.2 [Computer and Education]: Computer and Information Science Education - *Information systems education*;

General Terms

Experimentation, Human Factors, Verification.

Keywords

Virtualization, Virtual PC, Computer Networking, Virtual Network, Networking Labs, Virtual Machine.

1. INTRODUCTION

Computer networking courses mainly aim to teach students computer communication, network design, network protocols, network operations, install and configure operating systems and other networking topics. All these concepts become much more effective when these courses provide students a practical exposure towards these concepts [4]. It is generally acknowledged that learning computer networking concepts needs an individual practical experience [17]. However, providing an ideal physical environment for every single student can be very difficult and expensive. Moreover, practicality of

these concepts requires students to have administrative rights on lab computers which can cause trouble to the shared student lab environment. To overcome these issues, some educational providers have adopted virtualization technology to run computer networking courses [16]. Virtualization is the cost effective solution with a number of advantages including individual practical exposure which is not completely real but very close to the real environment. The organizational, administrative, implementation and management related advantages are well covered by the literature [3, 4, 6, 7, 8, 9, 14, 15] with the primary outcome of minimizing infrastructure cost, easy to administer, secure and individual practical exposure to gain computer networking experience.

This paper is concerned about the outcome of the analysis of the student's point of view about how well the virtualization tools have helped them in understanding computer networking concepts. The motivation for this analysis is from the review of the literature with the aim of addressing the student's opinion about the virtual environment and virtual tools used for computer networking courses.

2. BACKGROUND AND HISTORY

CP-40 was one of the earliest virtual machine that was developed for IBM System/360 Model 40[1]. A virtual machine can be considered as an isolated operating system installed on the operating system of physical machine. In general, a virtual machine can be classified as a software abstraction with the looks of a computer system's hardware (real machine) [11]. A number of virtualization tools are available in the market among which Virtual PC and VMware are widely used in the computer education. These tools provides a number of benefits including the concurrent execution of multiple operating systems in multiple virtual machines within single physical machine allowing students to network them within virtual to virtual and virtual to physical network. Another significant advantage of using these tools is the portability of virtual machines. Students can take virtual machines on to a portable storage media and can practice outside the campus.

Students using virtualization technology can get a practical exposure to run multiple server and client operating systems on a single physical computer and configure them to communicate just as physical local area network [13] with a flexibility cloning virtual machines, adding and removing virtual machines as long as their physical machine supports them.

Virtual PC is used by the computer networking students at AIS St. Helens for the hands-on practice. Using this tool, institute has solved a number of challenges for network teaching and practice like:

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- Students require administrative privileges to work on lab computers.
- Each individual student requires more than one computer to build network.
- A whole room is required for the physical network.
- Hardware required to keep these labs up and running is costly and needs regular up gradations.
- Old hardware breakdowns and operating system crashes during the course.
- Lab building and proper configuration of all computers beforehand is time consuming.
- The physical lab is difficult to scale.

However, considering virtualization as a solution to these challenges and its other key advantages in computer networking courses, it is still not a real environment that students may be facing after the completion of their qualifications. This forms the basis of this paper to understand the effectiveness of use of virtualization technology in computer networking courses according to the learner's point of view.

3. METHOD

A questionnaire was developed to obtain information about student's satisfaction level against two main parameters like academic background and experience. The academic background is further divided into academic qualification, professional qualification and qualification in progress. Similarly, experience is categorized into computer networking related experience, software related experience and non IT related experience. The satisfaction level is recorded on the scale of 1 to 5, where 1 is very dissatisfied and 5 is very satisfied.

We chose this questionnaire because the tool is widely used for quantitative research. As this tool provides a quick and easy way to collect data, we designed it to be simple, short and easy so that it should not consume too much of the students time yet still provide us with valuable data. The study was conducted in August 2012 at the end of semester 2, 2012 at AIS St. Helens. The data was collected from 22 students studying Diploma in IT level 5, Diploma in IT level 6, Graduate Diploma in IT level 7 and Bachelor in IT - Network Major courses within the information technology programmes at AIS St. Helens. The feedback from students enabled us to look deeper into the students' attitude towards the use of virtualization technology for network practice.

According to Yang [15], the students using virtual PC for system and network administration courses gave positive feedback and have rated class and projects evaluation high at the end of the semester.

Once the data collection was completed, results about using virtualization technology in learning computer networking concepts were analysed with some varying and interesting outcomes which is discussed in the findings section.

This research was conducted under the auspices of AIS St. Helens research committee ethics protocols.

4. FINDINGS

The questionnaire was completed by 22 students studying various computer networking courses, one from a level five

course, 13 from the BIT course and 8 from a level 7 course. Not all networking students were interested in the survey but most of them commented anecdotally that virtual PC really helped them in learning the concept and a few said that it will be nice to have physical devices as well along with the virtual environment. All these students were given a hard copy of the questionnaire to fill in at the semester end.

From the analysis it is found that virtualization technology helped students in learning network concepts but the satisfaction level varies according the different parameters as discussed earlier. The results are elaborated on in the following sub sections.

4.1 Satisfaction levels against qualification

We hypothesised that the existing qualification of the students may be a significant factor to understand the use of virtualization tools in computer education. We found that, out of the 22 students, 10 (45%) had just finished high school, 6 (27%) had already completed a computer science bachelor's degree, and 4 (18%) had completed a diploma level 6 and 7 related to computer science. For the remaining two students (9%), one had a master degree qualification, and the other a level 5 diploma not related to computer science (See Figure 1).

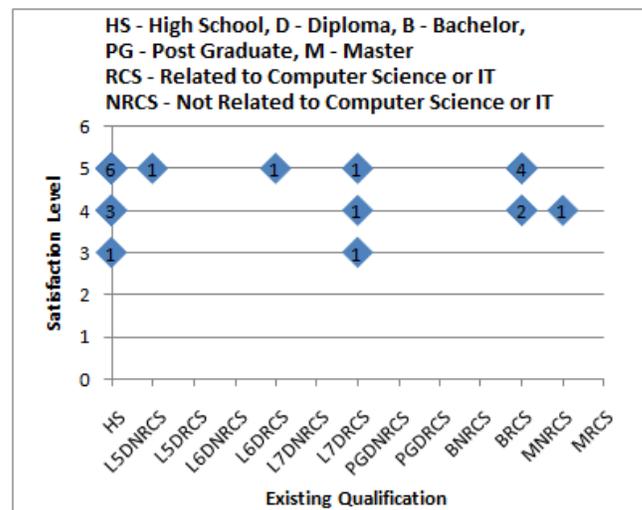


Figure 1: Student's level of satisfaction against their qualification.

Most of the respondents (91%) rated very satisfied or satisfied, with only 2 students who were neutral about their level of satisfaction. We also found that students who had just finished high school and students who had a computer science bachelor degree found virtualization very helpful in their studies, but a few bachelor degree students, as discussed earlier, commented anecdotally that they also required physical devices for hands-on (See Figure 1.)

4.2 Satisfaction level against experience

Another significant factor that we hypothesized could be the prior experience of the students: Computer Science, IT related, or non- related before they enrolled in computer education. We found that 59 % of the students had no experience related to computer networking and it also showed a trend that higher the computer networking related experience lesser was the satisfaction level with virtual tools (See Figure 2). This trend is

stronger with the involvement of more experienced students in the survey as figure 2 shows only three students (14%) with more than two years of experience in computer networking.

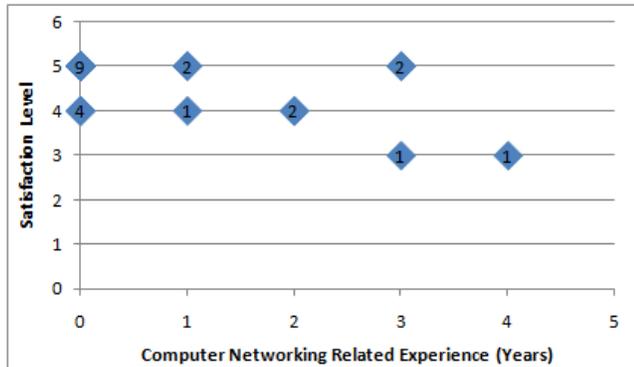


Figure 2: Student's level of satisfaction against computer networking related experience.

Students who had some software related experience also showed positive feedback towards the use of virtualization tools in the computer network study. Thirteen out of 22 students (59%) rated very satisfied, 7 (32%) satisfied and only 2 students rated neutral to the satisfaction level (See Figure 3). The results of this question also showed that the students who didn't have any computer network related experience, or in other words were new to the use of virtualization tools in network courses, found virtualization technology very helpful in learning and practicing computer networking concepts.

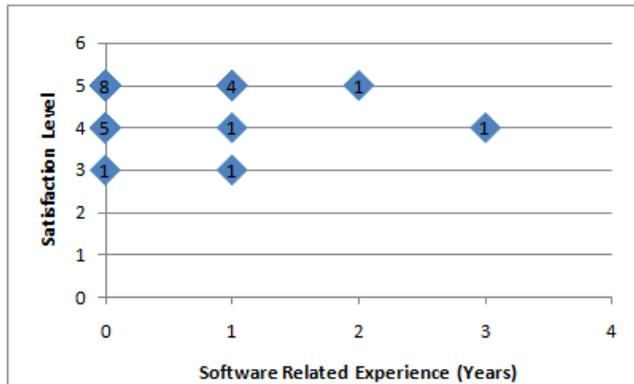


Figure 3: Student's level of satisfaction against software related experience.

Almost similar figures of student's satisfaction level were found for the non IT or computer science related experience. We found 59% rated very satisfied and 32% rated satisfied except for two students who rated neutral.

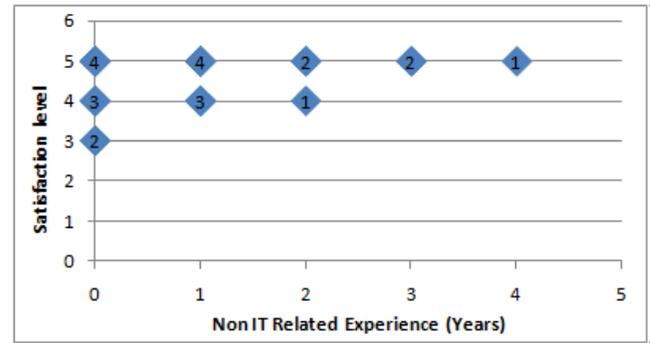


Figure 4: Student's level of satisfaction against non IT related experience.

According to the discussion with other network staff members, market (Tanveer and Sione, personal communication) virtual PC had helped students to get individual hands-on experience and students liked practicing in virtual environment but at the same time they also thought that the students needed exposure to the physical environment as well so that they could be familiar with the devices used in industry.

5. DISCUSSION

This survey, as conducted at one institution with limited questions, has confirmed the findings of others as discussed in sections 1 and 2 above, that the virtualization technology is useful in computer networking courses. We can see from our findings that none of the students are dissatisfied with using virtualization tools for network teaching. Students who have just finished high school and the students who have either diploma or bachelor degree related to computer science or IT are most satisfied with learning computer networking concepts using virtualization tools.

On other side, we see interesting results that those students with three or more years of work experience in the computer networking field were not as satisfied, whereas those students with work experience related software field, or any other non IT or computer science field like business management, hospitality, travels and tourism field etc. were satisfied with virtualization tools independent of the number of years of work experience they had had. We also received some comments from the students studying bachelor degree in Information Technology - network major that they would like to use physical devices in network teaching class along with the virtual tools.

6. CONCLUSION

Based on our findings, it can be concluded that using virtualization tools for computer network teaching provides a number of benefits to students studying networking. Students who have just started IT or computer science study after finishing high school appreciate the virtual tools most. In our opinion, virtualization tools are very useful and helpful in network teaching and learning fundamental concepts, but a combination of virtual and physical environment is recommended for teaching and learning advanced concepts in computer networking so that students can apply and verify their skills gained in virtualized environment onto a real physical device environment. This will increase their confidence in what they have studied and they will be able to learn more about computer networking with practical experience.

7. ACKNOWLEDGMENTS

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