

## **A Comparative Study about Linux Laboratory Environment**

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### **ABSTRACT**

This paper presents a comparative study about the development of a network based laboratory environment in the “UNIX introduction” course for undergraduate students. The study results and the response from the students from 2005 to 2007 will be used to better understand what kind of method is more suitable for students. We also use the data collected to adjust our teaching strategy and try to build up a network based laboratory environment.

Keyword: Linux, Virtual Machine, Live-CD, Remote Log In, Study Portfolio

### **INTRODUCTION**

Linux operating system is becoming more and more important in the industry and commercial world (Silberschatz, 1999; Tanenbaum, 2008). For the challenges of their graduates, more universities even try to train the students to have some license of Linux. Due to the popularity of Linux, “UNIX Introduction” is a compulsory or strongly suggested elective course for the computer science, information technology, and information management department students of many universities.

The best way to learn this course is learning through involvement in practical laboratory assignments, e.g. install and configure Linux operating system, create a directory, assign user rights to files and directories, write and execute a script, etc(Sarkar,2006; Young,1993; Anderson,1996). Therefore, students should learn this course through a computer-based environment, so how to set up such environments is an important issue, but little has been reported about a network based laboratory environment set up. On the other hand, how to record the student’s learning portfolio to better help their study becomes an important issue for the teacher (Wade, 1996; Kicklighter, 1999). So, we try to build up a network based laboratory environment for the “Linux Introduction” course and also try to find an easy way to collect students’ study portfolio to better help their study.

There are many ways to let students get involved in the laboratory experiments of the “UNIX Introduction” course. Generally, these can be categorized as (1) install the UNIX operation system in a computer (2) install the UNIX operation system in a virtual machine that runs under Windows (3) use a UNIX Live-CD (4) remote log in to a UNIX Server.

The above laboratory methods for practicing Linux will be described more thoroughly below, and then we will analyze the advantages and drawbacks of each method. The practical teaching experience will also be presented for comparison. Finally, we will give some suggestions to those who will engage in this kind of course.

### **COMPARISON OF LINUX EXPERIMENTING ENVIRONMENT**

In the following subsections, we will explain different Linux course laboratory environments.

#### **Install Linux in a computer**

The best way for learning Linux is to install the Linux operation system in a computer personally, and the author believes that this practical experience will be helpful to the learning of this course. Actually, this is a compulsory laboratory part of our course outline. Students enrolled in the Information Technology department of our university can rent a laptop PC from the school freely, so we require every student attending this course to install the UNIX operating system in his laptop. Sometimes, it is inconvenient for the university to have such laboratory condition. The following methods can be used to solve this problem. (1) Students attending the course can be arranged in different time to practice installing the Linux operating system in some specific computers. (2) All the students attending the course can practice installing the Linux operating system at the same time. After the course, all the computers should be restored to its initial state with some backup software, like Norton ghost. (3) Every student has a removable hard disk that can be plugged onto the computer in the laboratory. The first two methods can be used for installing the Linux operating system only, but students still need some laboratory environment to practice the Linux command. The third method seems good, but not all laboratories have such a condition. There is still the need to find some other methods to let students practically do the laboratory assignment of the course.

**Virtual machine**

Virtual machine is used to emulate a virtual computer on the system, and the users can install another operating system in the virtual machine. Virtual machine can provide students the laboratory environment without altering the current operating system, so it is very convenient for those who do not want to install the Linux operating system. Although, it seems quite good, but actually a virtual machine is just an emulating environment. It means that it is not a really environment after all. Students may not have the real experience of a multi user environment or personal web page. Especially, the teacher can not easily gather the laboratory results and the exercise from students, and this experimental result and exercise can help teacher to better understand the learning result. The virtual machine seems to be a good option for the Linux experimental environment, but whether the teacher should choose such an experimental environment should be thoroughly evaluated.

**Live CD**

Live CD is a disk of CD that contains the Linux operating system, and users can user this disk of CD to boot the computer. The merit of using a live-CD is that the users need not install the Linux operating system. This means the computer hard disk will not be changed after the use of a live-CD. Although the live-CD will not alter the data in the current hard disk, users can still store their data in the floppy disk or the flash disk.

Still, it is very convenient for those who do not want to install the Linux operating system, but it is not a really installed environment. Students may not really understand the really operation of a Linux from such kind of environment. Furthermore, it is still hard for the teacher to gather the result of laboratory assignments from all the students, so it is not easy for the teacher to know the study result of all the students immediately.

**Remote log in**

Another Linux laboratory environment is to remote log in to a Linux Server, and then the student can practice all the Linux command from their own terminal. The teacher should install a Linux Server firstly, and the Linux Server should be connected to the Internet with a fixed IP. Furthermore, all the computers in the laboratory should be connected to the Internet, and their IP can be fixed or dynamically allocated by a DHCP server. Finally, all the students attending the Linux course should have an account to be able to log into the Linux Server.

The “remote log in” method mentioned above is another option for students to experiment the Linux command. The results of laboratory assignments of all the students are stored in the Linux Server, so the teacher can easily gather the study portfolio of all the students. Study portfolio is very important, because the teacher can find out the study problem in the early study stage, and find out those who need to be paid special attention.

The teacher can also let every student have their personal page in the Linux Server, and students are always interested in practicing making their web page.

There are still something can not be fulfilled in the “remote log in” method, like X window, and some advanced commands, but it suits for an introductory course.

We list all the laboratory environments mentioned above in Table 1 for comparison. The teacher can choose the one that suits his condition.

**Table 1: Comparison of different Linux laboratory environment**

Environment	Advantage	Limitations
Installing Linux	Really install Linux OS	Every student needs to have a computer
Virtual machine	The original OS need not to be changed at all	Not a real Linux OS, just a emulation environment
Live-CD	The original OS need not to be changed at all	OS is not installed in the hard disk
Remote log in	Teacher can gather study portfolio of all students	Some advanced command can't be used

## ANALYSIS OF LEARNING OUTCOMS

### Study background

We will use the “UNIX introduction” course of the Information Technology Department of Ta-Hwa Institute of Technology as a case study in this section. The data collected from 2005 to 2007 will be presented and analyzed to support our adjusting in the laboratory environment used in this course.

Day time student enrolling in the Information Technology department of our university can rent a laptop PC from the university freely, but the student enrolling in the nighttime department of the Information Technology department of our university doesn't have this option. The reason for this policy is because most night time department students need to work in the nearby area, especially in the Hsinchu Science Park, so it will be inconvenient for them to carry and take care of a laptop. Furthermore, the nighttime department students are from different study backgrounds, so the teacher needs to pay more effort to let them be interested in the study. According to the background and

resources of our university, we decide to make the best use of the network resource to increase the study efficiency of the students in the night time department.

The policy is as follows. Every day time student attending the “Unix introduction” course needs to install Linux operating system in their rented laptop, and the teacher will help them with the problems they encounter. Students in the night time department attending this course will be arranged in groups of 5 to install Linux operating system in some desktop computers in a pre-arranged time schedule. Students both in the day time and night time department will also be required to finish their laboratory assignments in some different laboratory environments as described in Table 2. The symbols used in Table 2 are listed below.

**Table 2: Laboratory environment used in different year <sup>1</sup>**

	2005	2006	2007
Day time students	A、C	A、E	A、C、E
Night time department	X	B、C、E	B、D、E

The teaching materials including the power point slides, web page, and stream video authored by the StreamAuthor can be downloaded from our course website, so the students can self study after the class.

The preparation of the laboratory environment for the night time department students is under consideration of their special conditions, so we decide to make the best use of the Internet resources. That is the reason why we adopt the remote log in the 2006 night time department course. The Students of Night time department can utilize Internet to do the laboratory assignments off the campus if they are too busy to attend the class.

We also decide to combine different methods to make the laboratory environments more attractive and selective.

After the 2006 course, we decide to let the day time students to utilize the internet also, because we find out the profound results of internet usage.

In 2007, we developed a set of programs to check the students’ laboratory assignments automatically. This set of programs can largely help teacher to find out students’ problem and try to help them as early as we can.

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<sup>1</sup> A: students need to install Linux operating system in their laptop  
 B: Students need to install Linux operating system. In some desktop computer in some scheduled time.  
 C: Virtual machine  
 D: Live-CD  
 E: Remote log in  
 X: means the course doesn’t exist in this year.

### Student Performance

The result of quantitative measures is presented to evaluate the different laboratory environments used in the course. Students will be required to sit the midterm and final examinations, and the test sheet includes single choice, multiple choice, and explanation problems. The laboratory assignments will also be scored and considered as the study result. Table 3 lists the result of the course taken in 2005 and 2007.

**Table 3 Study results of the course in 2005 and 2007**

year	2005	2006	2006	2007	2007
Class	Day time	Night time	Day time	Day time	Night time
Student number	44	23	40	41	26
Average	60.86	71.65	70.48	73.24	79.15
Standard deviation	11.82	9.39	5.77	6.87	6.12

We can draw out the following conclusions from the result listed in Table 2.

We use virtual machine as the experimental environment for the day time students in year 2005, and we use remote log in as the experimental environment for both the day time and night time students in year 2006. We can find out that the study result in year 2006 shows apparent improving and the deviation decreases also. The reason can be concluded as follows. Firstly, students seem to be more active in their laboratory assignments because the experimental results can be collected immediately after the class. Secondly, the results of laboratory assignments and the study portfolio can be more easily gathered, so teacher can find out the study problem of some specific individual, and then find out some way to help them.

### Student response

Students can rate a course by answering a questionnaire containing questions about the course and the teacher. Each question will be rated as strongly agree, agree, disagree, strongly disagree, and undecided. The result is listed in Table 4.

From the response, we find out that students in year 2007 course respond more positive to question 3. This can be explained as the teacher can collect study portfolio through network, so the teacher can quickly help the students. Furthermore, students' response appears more positive to the teacher and the course, especially for the students of the night time department.

**Table 4 Students' responses of the course in 2005 and 2006<sup>2</sup>**

Question	class	SA	A	D	SD	U
Q1	2005 Day time class	27%	61%	3%	0%	9%
	2006 Night time class	46%	54%	0%	0%	0%
	2006 Day time class	43%	51%	0%	0%	6%
	2007 Night time class	46%	53%	0%	0%	1%
	2007 Day time class	44%	55%	0%	0%	1%
Q2	2005 Day time class	21%	73%	0%	0%	6%
	2006 Night time class	43%	54%	0%	0%	3%
	2006 Day time class	40%	51%	0%	0%	9%
	2007 Night time class	46%	51%	0%	0%	3%
	2007 Day time class	45%	52%	1%	0%	2%
Q3	2005 Day time class	18%	67%	3%	0%	12%
	2006 Night time class	49%	49%	3%	0%	3%
	2006 Day time class	41%	57%	0%	0%	0%
	2007 Night time class	52%	47%	0%	0%	1%
	2007 Day time class	51%	48%	0%	0%	1%
Q4	2005 Day time class	21%	64%	0%	0%	12%
	2006 Night time class	43%	51%	0%	0%	3%
	2006 Day time class	40%	57%	3%	0%	0%
	2007 Night time class	47%	51%	%	0%	2%
	2007 Day time class	48%	49%	0%	0%	3%
Q5	2005 Day time class	27%	61%	0%	0%	12%
	2006 Night time class	37%	54%	6%	0%	3%
	2006 Day time class	43%	54%	3%	0%	0%
	2007 Night time class	44%	54%	0%	0%	2%
	2007 Day time class	44%	53%	1%	0%	1%

## CONCLUSION

“Unix Introduction” is an important subject for students of the computer science, information technology and information management department. How to set up a laboratory environment for students is crucial for the students, and how to motivate students to learn the course is also important to the teacher.

The author would like to give his personal suggestions from his teaching experience from 2005 to 2007. Firstly, the best way to learn this course is through practical

<sup>2</sup> SA: make best use of the network, A: Agree, D: Disagree, SD: Strongly Disagree, U: Undecided

Q1: Teacher is well prepared

Q2: This course is a valuable learning experience

Q3: You can find the teacher when you need help

Q4: Teacher can adjust the teaching step as needed

Q5: The evaluation of the final score seems reasonable and fair

experiments. Secondly, the preparation of a suitable laboratory environment is important for this course. Thirdly, the teacher can collect the study portfolio of every student through the remote log in method. Lastly, because of the usage of network, students can do their laboratory exercises even they are off the laboratory, and this especially suits for the students of the night time department.

This paper compares different Linux laboratory environments, and also presents the teaching experience from year 2005 to year 2007. The study of this course can be extended to other course of the like.

A network based laboratory will help the vocational school students much, especially for those who work daily and study at night. Students can easily access their studying material, do their exercise and laboratory assignments through network. The teacher can help students through their study portfolios. This has been verified through our “UNIX Introduction” course experiences.

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