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An Evaluation of a Practical Training Course in IT at University Level

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Abstract - The importance of providing technical skills is often underestimated in the course of a university degree mainly in the Engineering and scientific fields of study. It is often the case that there is a mismatch between the practical skills that students should have at their workplace and the technical skills and knowledge that they acquire at University, where much emphasis is laid on theoretical concepts. Our concern here is the provision of relevant practical skills for Computer Science students. For the first time, the computing department at our university has set-up and conducted a fully practical module for Computer Science students. Our aim in this paper is to evaluate the effectiveness of this module and the learning-by-doing approach that has been adopted. This paper also provides a comparison of the module delivered with popular technical professional courses. The results of our feedback form have also been presented. To the best of our knowledge, this is the first detailed evaluation of a practical training course in IT at university level.

Keywords: practical training, operating systems, networking, email, internet, PC Assembly, recovery, security

I. INTRODUCTION

The Practical Training module is a newly introduced core module of the *BSc (Hons) Computer Science* programme at the University of Mauritius. The main aim of this module is to equip students with the necessary theoretical, technical and practical skills which will be of great value to them wherever they need to deal with computers. The course is currently being followed by 120 students. However, the students were grouped in batches of 20 for each practical session. Each session lasted over five days for a total duration of 30 hours. The groups were kept small to maximise learning. Currently, there are no exams for this module. Students are assessed though practical work in the labs and small written tests and receive only a satisfactory mention. At least 80% attendance is also required. Those who do not receive a satisfactory mention need to take up the module again in the next academic year. Since this practical training module has just been introduced, it does not carry any credits.

An active learning (or learning-by-doing) approach was adopted throughout the duration of the course. Students were given ample time to understand what they were doing. They were even intentionally driven towards potential problems from which they had to find their own solutions and discuss them with the tutors.

As such, students were given a number of exercises to practice upon. They were also provided with many insightful scenarios where detailed investigations were required. Students were allowed to use the Internet and they were also allowed to work as a team on certain problems.

The practical training module broadly covered the following topics: installation of operation systems and applications software, setting up and configuration of wired and wireless networks, assembling and disassembling of PCs, installation and configuration of peripheral devices, configuration of emails and internet parameters, security issues and recovery techniques and procedures.

To our knowledge, this is the first time that our Computer Science department is running such a practical module and thus it was important to evaluate our work so that future tutors and trainers can improve upon our work. We firmly believe that it was a laudable initiative on the part of our department to introduce such a module. The contents of this module have been tailored to provide students with current IT skills which will undoubtedly benefit them at the university and even at work later on.

We also conducted an online survey to gauge the effectiveness of the module from the students' point of view. Students were asked various types on questions and their answers were stored and then analysed. Results of the survey are also presented in this paper.

The rest of this paper is structured as follows: section 2 provides an overview of some evaluations of practical courses. In section 3, we analysed some popular technical and professional courses and briefly compare them to our own module. Section 4 gives the specific requirements of this module and an overview of how the module was carried out and. We present the results of our survey in section 5 and section 6 concludes the paper.

II. RELATED WORK

Despite the intensive research that we did on the internet, we came across very few studies that have been done to evaluate practical Information Technology courses at University level. This might be partly explained by the fact that most IT courses at University level are either purely lecture based or a mixture of lectures and practicals. However, we believe that most of these practicals are software based whereas our practical training module is mostly hardware based. Thus, it became very difficult to compare our work with previous work of similar nature. Nevertheless, we provide a brief account of work which evaluates other courses at University level.

Christen [1] discussed the evaluation of a graduate level data mining course with both graduate students and industry participants. He concluded that his students found the course to be very interesting, useful and that it contained the right amount of theory and practical work. Most of these students would have

liked the course topics to be covered in more depth. In these respect, Christen's evaluation of his course is quite similar to our own evaluation. There were 26 students in his tutorial class.

Martin et al [2] conducted a formative evaluation of her computer literacy course in order to better evaluate the contents of the course and the best way in which these contents should be delivered. Students preferred hands-on practical rather than long lectures. Again, students wished that some topics should be covered in more depth. There were about 18-24 students in each batch. Martin felt that having a teaching assistant would surely help and that more collaborative activities should be encouraged. She also believed that even traditionally difficult topics can be taught in creative ways to impress students upon their importance.

Victoria et al [3] conducted a study to assess the impact of computerised case studies on pharmacy students' ability to learn and apply chemical principles to solve complex therapeutic problems. In [4], the discussion is about providing online training to multiple recipients, the challenges that arose and these were resolved. The use of electronic surveys to evaluate courses was addressed by Moss and Hendry [5]. In [6], the authors designed some methods for the evaluation of training provided by trainers so that they can then use this feedback to improve the delivery of the training in order to meet the needs and expectations of the trainees.

In 2006, WHO/UNICEF developed a 6-day course with 20 trainees (clinicians) and four facilitators. The contents were provided through the use of a CD-ROM. The study showed that the computer-based learning (CBT) program was as effective as conventional lectures and clinical practices but was 12% less costly [7].

III. PROFESSIONAL COURSES

There is currently a real craze concerning technical professional courses and many potential employers prefer to employ people having those professional certifications. Some of the most popular professional courses are CompTIA A+ and Network+ [8], Cisco Certified Network Associate (CCNA) [9], Microsoft Certified Systems Engineer (MCSE) [10] and Linux Professional Institute (LPI) [11].

The practical module that was developed at the University of Mauritius tried as far as possible to gather important topics and concepts from these technically-oriented professional courses. E.g. installation of Windows XP and an understanding of underlying concepts forms part of one of the client module, "Installing, Configuring, and Administering Microsoft Windows XP Professional (70-270)" of the MCSE certification. Similarly, installation of Linux forms an important part of the LPI101 certification. Furthermore, arranging RJ-45 cables, cross and straight-through and connecting computers making use of a switch to form a small network, constitutes part of an important chapter of CCNA - ICND1 and CompTIA Network +. Assembling different hardware parts to build a running computer and an understanding of the importance of each of these parts is covered in CompTIA A+ hardware.

However, due to time constraints, we have not been able to cover all these concepts in details but the aims and objectives of giving the students an overview of all these concepts that are normally covered in these professional technically-oriented courses have been amply achieved through a number of practical sessions. We believe that our practical training course has many of the important components of all of the above mentioned professional certifications and does not restrict the students to only one field of study.

IV. REQUIREMENTS AND CONTENTS OF THE MODULE

It is important to have the necessary resources in terms of equipment and qualified staff to deliver this course. Although the department did not have a dedicated hardware lab, the practical class was run in a normal lab but with additional equipment. 20 PCs were reserved for this class whereas only 10 of them were used for disassembly and re-assembly. All of them had network cards and had connection to the internet. We had also to identify 20 CDs of Windows XP Professional Edition and 20 CDs of Ubuntu 10.04 operating systems. Other equipment that were used were wireless LAN adapters, hubs, RJ45 Crimper/Stripper/Wire Cutter Tool, RJ45 Cable Tester, RJ45 plugs, CAT5 or CAT5e cable reel, network printers, scanners, vacuum cleaners with blower, screwdrivers among others.

Four lecturers were selected to deliver the course. They hold suitable technical qualifications such as CCNA and CompTIA A+ certification. Instead of having a lecturer responsible for delivering a whole session of 5 days to one batch of students, we used a slightly different approach. Thus, instead of allocating lecturers to batches, the lecturers were allocated to topics. Therefore, each lecturer was responsible to become master in their field to deliver the best content of higher quality to the different batches of students. Thus, one of us covered operating systems, another networking, still another one covered PC Assembly and hardware and the fourth one covered security issues, email configuration issues and recovery tools and techniques.

A. *Installation of operation systems and applications software*

On the first day of the course, students were given an overview of Operating Systems, both licensed and open-source. In the morning session, each student had to install a copy of Windows XP. They were explained the concepts of partitioning, file systems, configuration settings and they had to apply these concepts. Furthermore they were explained the importance of drivers and they were asked to identify hardware devices that required the installation of drivers. Once the operating system was up and running, students were also asked to install some common applications software like Microsoft Office, Acrobat Reader, Win Zip, etc.

In the afternoon session, after a demo by the tutor, the students were then asked to install Linux, more specifically Ubuntu as the distribution of Linux and they also had the opportunity to practice with some of the commands of Linux. Linux was new to most of the students and they really loved working on Ubuntu. Many of them wished that the course on Linux was covered in more depth. Typing commands to execute tasks which are easily done through a GUI in Windows-based OS was interesting for the students.

B. *Setting up and configuration of wired and wireless networks*

Network was the topic that was introduced to the students on the second day of the course. Since most of the students had only a little or almost no knowledge of networking concepts, a handout was prepared and distributed to the students for them to get used to the technical terms. The document contains some basics on computer networking like types and categories of networks, types of cables and communication channels, protocols that are used in computer networks and some advantages

and disadvantages of computer networks. Wireless networks were also introduced. The day was kicked off by doing an interactive session of one hour, whereby, the document submitted to students was reviewed by asking questions which had to be answered orally by the students. Once the principles of network addressing were understood by the students, they were then asked to perform a series of practical networking exercises.

The first exercise consisted of several questions, where for each, the student had to use network driven commands, such as ping, traceroute, netstat, arp and so on, to retrieve information about the network connection of the computer they were using.

The second exercise was a step-by-step guidance of how to set-up the IP Address of a PC manually (static). This step was essential as it would allow the students to complete the exercises that followed. The third exercise had as title "Setting up of a LAN", whereby the students were given a switch of 16 ports and a number of straight cables. This exercise was performed in groups of 4 students due to the limited number of devices available. Thus, they had to decide on the IP addresses and the subnet mask to be used in a single network. They performed the wiring and assigned the IP addresses as they did in the second exercise. Then they tested the network configurations, by using the commands learnt in the first exercise. Finally, they were asked to do file sharing, by creating and joining a single network, created with the use of the Windows Network Set-up Wizard.

The objective of the fourth exercise was to connect two PCs to create a peer-to-peer network. This necessitated a cross-over network cable. They were also asked to assign IP addresses of a different class, test the connectivity and then to perform file sharing between the two PCs. Files had to be shared from both PCs in turn.

The last exercises were based on wireless connections. For exercise 5, students had to configure a Netgear wireless router using a network cable, set-up the WEP key, and then connect several computers using the same key to the same router to form a network. They also had to test the connectivity and perform file sharing. And lastly, for exercise 6, the students' set-up a peer-to-peer wireless network. They managed most of the tasks without much difficulty as hand-outs were provided with everything written. All the steps were clearly explained in a very simple language.

C. Assembly and disassembly of PCs

Day 3 was being eagerly awaited by the students as this was the day on which PC Assembly and Hardware issues were scheduled for. As soon as they entered the computer lab, they removed their screwdriver from their bags as if they were going to war with the lab PCs. The session started with the showing up of a number of hardware components. Students were then asked to identify the hardware. CPUs, motherboards, RAM module, graphics cards, networks cards, modems, cables (SATA, PATA, USB, FireWire), Heat Sink, hard drives, optical drives etc… were shown to the students. Many of the students had trouble identifying the correct hardware thus making this exercise worthwhile.

Students were then shown a video entitled, "Learn to Assemble, Build a PC" [12], downloaded from YouTube. It is a 10 minute video which starts with explaining all the common hardware components that are required to assemble a PC. The purpose of each component is also explained in the video. Students were asked to watch and listen to the video attentively as their next assessment was based on the contents of this video.

Thus, after the video was over, students were given a sheet of A4 paper with some small questions about PC components. They had to write their answers in the same sheet and submit to the tutor. They were given 30 minutes to do this activity. Students were not allowed to ask for answers from their friends but they were allowed to use the internet to look for possible answers. After this exercise, students were given the possibility of connecting the hardware components mentioned above to a motherboard. These were not parts of a live PC. They were broken pieces but could nevertheless be used to teach students how to connect cards, memory modules, cables etc… to the motherboard. After this fruitful exercise, students were once again given some paper exercises which dealt mainly with computer hardware inside the casing. For most of the trainees, this was their first experience with the insides of a PC, thus it was important to teach them as many things as possible before the much awaited hands-on practicals on working PCs.

In the afternoon session, the tutor finally gave a PC disassembly demonstration to the participants. They were keen to follow what the instructor was doing and they listen attentively to all the advice and safety instructions that were being given. Once the demo was over, students were allowed to disassemble a live PC under the supervision of the tutor. Students were very careful when removing and handling computer components. They were allowed to remove the hard drive, optical drives, memory modules, network card, graphics card, CPU fan, heat sink and power supply. Unfortunately, students could not be allowed to remove the CPU from its socket as there was the risk of damaging the pins (Pentium IV CPUs), which would then make the PCs unusable by the other batches. Once all the participants were able to disassemble the PC, another demonstration was given on how to assemble the PC back to its original state. The difficult part was to know how to connect the IDE cables and the power supply to the motherboard and to their respective devices. The tutor explained this connection a number of times so that students do not make any fatal mistakes. Students were then given the possibility to assemble their PC. On average, the majority of PCs boots up on their first trial and a few on their second or third trials after minor adjustments with the graphics card, RAM modules or CPU power cable. On average, 1 PC did not boot every 2 sessions. This was considered to be a reasonable number as for many students, this was an entirely new experience but very enriching one.

D. Email, Security issues and Recovery techniques and procedures

Day 4 started with a brainstorming session on the use of security issues. The students were made aware of the different techniques to be used to keep their computers secure, e.g. antivirus, anti-spyware, automatic updates of operating systems, use of usernames and passwords and the creation and use of restore points. The students were then asked to download a free antivirus and an anti-spyware, to perform an update of the engine and virus definition and to perform full scan of the PC.

The next set activities were on emails. All the students had more than one email accounts and felt confident in this morning session. However, the focus was not on sending and receiving mails but on the ability to use email services more effectively. Students were requested to complete a set of activities starting with the creation of two new different email accounts, one on Gmail and the other one on Hotmail. They were asked to create a personal signature and a vacation auto-responder which they successfully completed in minutes. They however encountered some difficulties in the next activity which was the creation of filters and labels, and hence requiring the help of the tutor. The next activity was to configure their Gmail account to automatically retrieve emails from their Hotmail account. Students were here apprised of the possibility of retrieving a number of email accounts under only the Gmail account which they found very beneficial.

The students were then given an insight of the Google Map Maker and were asked to create a markup for their residence and send this to their friends. They also had to create a suitable filter that would store the residence details of their friends based on the subject of the email.

The next activity concerned the creation of user accounts and the creation of shared folders for sharing of files. Since the students were already aware of the IP addressing, they were able to access the shared folders of their friends based on the IP address of their friends' PCs.

The activities of the afternoon sessions were based on recovery tools and procedures. The students were first explained the ways of resetting the BIOS passwords by making use of generic passwords and the BIOS battery.

In the next activity, the students were asked to assume that they have lost the password of the only administrator's account and had to investigate how they can have administrative access to the PC again. They were handed a copy of the Offline NT Password & Registry Editor [13] and were guided in order to clear the password of the Administrator account in the SAM file that cannot be accessed in Windows but can be using this Linux Boot Disk. The students were also shown how to make use of the security hole in Windows XP to change or remove the administrative password with a Windows XP installation CD.

For the purpose of the next activity, the students were divided into 2 batches, A and B, and were requested to note important observations. Students of batch A were asked to perform an automatic repair of the Windows XP operating System whereas the other batch had to install a copy of the Windows XP by leaving the file system intact. Then the students were asked to discuss the differences between these two approaches whereby the first one retains all the user accounts and the second one retains only the documents of the users.

For the last activity, the students had to work in groups of two. The aim of this activity was to remove one hard disk and configure it as slave on the other PC. The students were here shown how to re-adjust the jumpers to make a hard disk slave and master. They found this session on recovery tools and techniques very useful to them since they were not aware of the different means by which they can recover back their information from their hard disk. Many of the students had had similar previous situations and they either relied on the help of a technician or simply formatted their hard disk, thereby losing all their information.

E. Cabling and Assessment

Day 5 was kept for assessments. In particular, students were given a written test on networking and a practical test on networking where they had to prepare cross-over and straight-through cables. Students were first given a demonstration on how to prepare cross-over and straight-though cables using RJ-45 connectors and STP cables. The necessary equipment was then provided to the students to prepare their own cables. This task created problems even to the more able students as this was an entirely new task to them. The students were provided with a cable tester to test whether the cables were correctly wired.

Students also had to install appropriate drivers for scanners/printers (3-in-One). In the afternoon, their online skills were tested by asking them to locate materials using different search engines and browsers. In particular they had to configure a network printer on the Windows operating system.

Finally, after one week of training, students were asked to fill in an online feedback questionnaire to get their views and opinions on the teaching, content and delivery of this module. Some students did not fill the form, some had problems filling in the form and could not complete it but the majority of trainees filled the form well. The responses were then stored and analysed. The results are presented in the next section.

V. RESULTS OF SURVEY

In this section, the results of our survey are presented. We try to analyse and comment on each of our questions.

Out of 120 students enrolled for the Practical Training module, 88 of them responded to our online feedback form. Thus, a response rate of 73.3% was obtained. The form contained 22 questions: 17 MCQs, 3 True/False questions and 2 open-ended questions.

86% of students agreed that the aims and objectives of the module were clearly explained at the beginning of the course. 6% of students had no idea whether this was done. 89% of students also agreed that the delivery of the module was well organized.

92% of students agreed that the lecturer made use of visual aids, handouts, lab equipment and internet access. 74% agreed that all lecturers provided prompt feedback on assessed work. Only 2% said that none of lecturer provided prompt feedback.

76% of students mentioned that all lecturers started and finished on time. 7% said that none of them starts and finished on time. 83% of students found that the pace at which the course was delivered was just right. 7% found that the pace was a bit slow while the remaining students found that the pace was a bit fast.

92% of participants revealed that lecturers encouraged students' participation through group work. 94% of students declared that the assignments, tests, quizzes and other exercises have helped them to better understand the course materials.

90% of trainees said that lecturers were able to explain the material clearly and about the same number of students agreed that lecturers were able to present the materials in an interesting manner. 95% found that the lecturers were responsive to students' concern and were willing to answer questions. 97% of students were of the opinion that lecturers' voice could be heard clearly and that there were no problems of comprehension throughout the course. 96% of participants revealed that they liked the attitude of the lecturers. The remaining 4% had no idea whether they liked the lecturers' attitude or not.

82% of students mentioned that the quality of the material presented were of reasonable standard. 12% disagreed while 7% had no idea. 53% found that the overall quality of the module was high while at least 96% of trainees were satisfied with the overall quality of the module.

56% of participants felt that all the learning objectives of the course were achieved. 34% felt that only 75% of the objectives were met. And 9% felt that only 50% have been covered.

Students were also questioned about what was the most appropriate time to run this practical course. One third of them said that the current June/July slot is fine. This corresponds to their end-of-academic year holidays. One quarter of the students wanted the course to be delivered during holidays but in December/January. One fifth felt that having the module during the first semester of their first year would be more appropriate. 15% suggested the module to be run in the second semester. Only 2 students were of the opinion that the course should not be run in their first year but either in the 2nd or 3rd year of studies at the University.

82% of trainees agreed that the Practical Training module should be a core module of a Computer Science degree. 86% of participants suggested that this module should also have been a core module for both the Information Systems and Computer Applications programmes that our department is also running. 99% of students showed their willingness to follow a more

advanced course in computer hardware, networking, troubleshooting and operating systems if it is available free of charge by the university.Participants were also asked about the things that they have liked the most about this module. This was an open-ended questions and this allowed students to give out their views freely. Networking and PC Assembly were the most cited topics followed by Operating Systems, Email and Security. A majority of students declared that the course was very interesting and a significant number added that the course was fun and enjoyable.

Many students said that the training was done in a relaxed atmosphere, different from a classroom atmosphere. The lecturers were perceived to be very approachable, helpful and resourceful. Thus, they could ask questions without fear. The small batch size has also encouraged them to ask questions without feeling stupid. This also helped them to receive individual attention. Often, students were allowed to work at their own pace.

A large number of trainees realised the importance of having a practical oriented module where hands-on practicals were carried out. They also mentioned how this knowledge would be useful to them both at home and at work. For many, it was an enriching experience. A significant minority also added that the course should have been covered in more depth.

Only a minority of students realised that having four lecturers delivering the course instead on one only had a major impact on the overall quality of the module. Only a handful of students felt that having no exams for this module was a blessing.

The last question of our online questionnaire was asking for possible ways in which the module can be improved in terms of teaching, delivery and contents. Again, students showed their willingness to share their views, ideas and opinions on how this module can be improved.

The concern of the majority of students was the fact that they did not have access to satisfactorily working PCs. This prevented them from conducting many of the practical exercises properly. The internet connection was also very slow and in some cases, it was not available. Surprisingly, a quarter of participants wished that the course was conducted over a longer period, for example, two weeks and in more depth. However, some trainees found that 6 hours of training in one day was too much for them. Some of them suggested having three smaller breaks instead of only one.

Some participants wished that the trainers had made more use of videos and slide shows. Not surprisingly, students wished that they had more equipment and newer ones for practice especially for the networking and hardware topics. Some trainees wished that the part of Linux was covered in more depth as it was something entirely new to them.

A minority of students felt that the course provided everything they needed and that everything was fine. Consequently, they did not mention any improvement.

VI. CONCLUSION

This paper can indeed be very useful to our department and/or university for mounting future practical training courses. We also believe that it will be helpful to any other university, training institution or organisation wishing to deliver practical-based courses, mainly in the Information Technology field. We noticed that students who had no previous knowledge of dealing with computer components did not face any particular difficulty once appropriate instructions were given to them, even for the disassembly and assembly of computer hardware. Students of both genders seemed to have liked the course equally. Although the module was not examinable and did not carry any credits, the attendance rate of the students was well above the 80% threshold that was required to clear the module. Even though we managed to conduct all the practicals with a batch size of 20 students, we strongly felt that a batch size of 15 students together with the support of a qualified technician would be ideal since most of the students did not have any previous technical knowledge. We also strongly believe that in order to ensure the proper delivery of this module, there is a high need for a specialised training laboratory with the necessary equipment as discussed in the fourth section of this paper.

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