Using Virtualization to aid Student Learning in Traditional, Hybrid, and On-line courses

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Abstract

Providing students with productive hands on lab time is vital to the learners' progress and mastery of the course material. In stark contrast to the learners needs, schools are operating in economic times that are forcing computer labs to be reassigned and access to them limited. For example, Brevard Community College is operating on a four day work week. This cost cutting measure places limits on student access to campus computer labs that are vital to the success in computer courses.

To address budget constrains as well as ever changing student demographics, it is imperative that students utilize innovative tools to practice outside the traditional lab setting. Supplying students with virtualization software that emulates the classroom setting has enabled students to gain experience outside the physical classroom environment. Brevard Community College currently utilizes various virtualization software packages to enable traditional, hybrid, and online delivery methods while providing students with the best learning environment possible.

This intended audience for virtualization is currently students enrolled in operating systems courses, computer networking and security courses, as well as PC repair. The availability of open source and free virtualization software coupled with open source operating systems and academic licensing allows this technology to be deployed at a minimal cost to the students and the institution. This presentation will outline different methods for successfully using virtualization software in traditional, hybrid, and online courses.

Introduction

At Brevard Community College (BCC) there is a desire to provide lifelong learning opportunities to a diverse student population. In the Computer Information Technologies Department, we have a long tradition of providing traditional, hands-on education in many computer areas. The growing popularity of more flexible delivery methods intermingled with challenging economic and funding crunches has caused traditional, lab intensive courses to be delivered either hybrid or 100% online. But, a challenge has arisen. The ACM has just released its update to the IT Computing Curricula and it strongly encourages the incorporation of hands-on learning activities to reinforce theory and methodology (Lunt, Ekstrom et al. 2008). This paper will address the challenges to providing uniform, quality hands-on education in all three delivery methods.

Traditional Classroom

The traditional classroom is defined as students being required to physically attend a lecture/lab session for a given period of time throughout a semester. At BCC, we are fortunate to have IT

courses delivered in a fully equipped computer lab. It has been suggested in the literature (Chu 1999; Leitner and Cane 2005) that simply attending class will not provide enough practice for mastery of a given material. A problem that arose at BCC in multipurpose labs was if a student created and saved their work on a lab machine, there was no guarantee that the machine they were working on would be available after class. Other lab machines may be available, but their data is not there. To enable portability, a student can work in a Virtual Machine (VM) and save the entire session. Later, at any lab computer, the VM can be restored and work continued.

Hybrid Classroom

The hybrid classroom was created to enable more creative course scheduling. A hybrid course is one where a student must attend at least half of the traditional course time in class per week and spend the remaining time engaged in discussions outside the classroom. At BCC we are able to successfully deliver two night classes for students on one night, in a back-to-back manor. This allows for students to only make one physical trip to the college but gather information for two courses. The disadvantage of this scheduling is a limitation on the amount of hands-on time spent in the lab. VMs can be used by the students to practice in an identical environment – the same one that was demonstrated in the classroom. Here, the students have two choices; 1) save their VM in the lab and bring it home, or 2) simply recreate the lab environment at home in a VM of their choosing. In either method, the learner is able to spend more time with the material.

Online Classroom

Online classes are seeing a dramatic increase in enrollment at BCC. There are various reasons for this growth, but the fact remains that the quality of course is the same as the previous two delivery methods. To address the recommendations of the ACM (Lunt, Ekstrom et al. 2008), VMs were the solution to enabling students to participate in hands-on labs. VMs are a solution to this problem. VMs not only allow the student to experiment with the course material in a manner that will not damage their host system, but the professor can exercise far greater control over VMs to enable a cohesive experience across all learners. VMs simplify any troubleshooting problems that can arise with the students or translations issues that occur between students using different operating systems.

Virtual Machines - What are They?

Virtualization technology has seen recent industry wide adaption as a viable testing platform and server consolidation tool. Simply stated, a single host computer can support multiple virtual machines. Every VM is contained within its own 'sandbox' that does not allow for cross contamination from the VMs to the host or from VM to VM. The host and VM function as if they are the only computer running on that hardware. To the student, this means that all applications need to be installed separately on each VM. Moreover, problems in one VM do not adversely affect other VMs – including viruses and system crashes.

Flexibility with the security of host systems is another key reason for virtualization deployment in lab settings. BCC, like many other institutions, have lab computers that do not allow students to install software. To get around this security setting, all lab computers have Microsoft Virtual PC (Microsoft 2009) installed on them. This will allow a student to use an existing VM and con-

tinue work from a previous class meeting; allowing admin privileges on the VM for software installation or any other admin related task.

There are many different VM solutions that are widely available for student use at home or in the classroom. Please see Appendix A for a listing of VM manufactures and suggested scenarios for usage. The first step in using Virtual Machines is to install the VM software on the host system. This procedure is the same as installing any other type of software on the host system. Once installed, the user is free to begin creating new VMs for usage. Figure 1 is a common representation for the relationship of VMs to the host operating system and Figure 2 displays a Microsoft XP host system running a Microsoft Vista VM using Microsoft's Virtual PC and a Microsoft Vista host and an Ubuntu VM in VirtualBox.

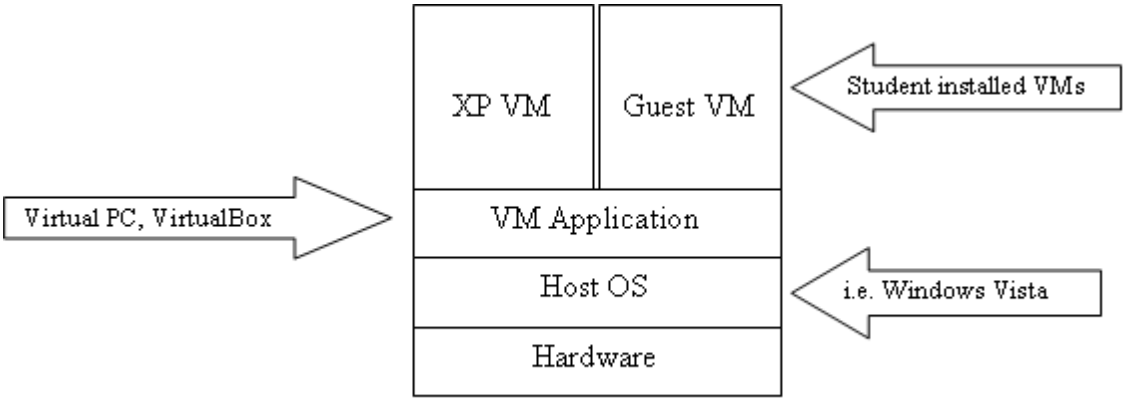

Figure 1. Relationship of PC hardware, host OS, VM application, and guest VMs.

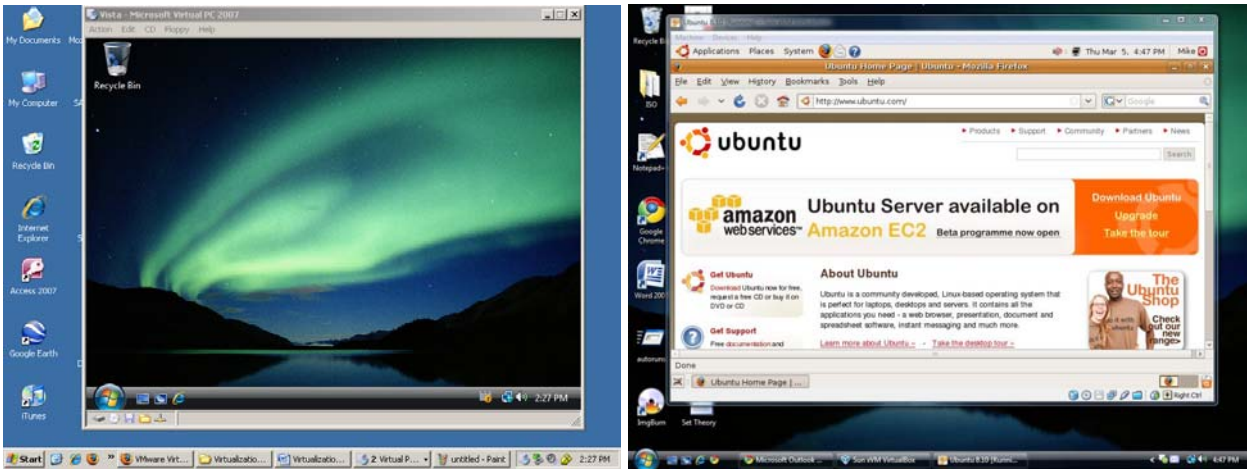

Figure 2. XP host with a VM running Vista and a Vista host with a Linux VM.

How do Students use VMs in a Traditional Classroom setting?

We started using VMs about 5 years ago in most OS classes when removable hard drives became economically difficult to justify. We needed a way that allowed students the freedom to install

their own OS (Windows XP or Windows 2003 Server) and have administrative privileges on them. Also, the installs needed to be pervasive throughout the term. As the technology matured, VM were deployed in Security, Cisco, and Linux courses.

The benefits of VMs in the traditional classroom are easily realized by the increase in direct student participation with the material. An added benefit to the instructor is the ability to have 'spare' VMs that students can simply copy if a catastrophic situation arises. Using this spare copy VM, a student that corrupts their VM can be back up and running in 5 minutes, no need to re-install the OS.

Students are also free to take their work home with them and continue with the content covered in the classroom. Most VMs are between one and three gigabytes in size and can be easily transported using a DVD-RW or USB jump drive. BCC has also partnered with Microsoft and purchased an academic license through the MSDN Academic Alliance (2009). This program allows computer science students' access to all of Microsoft's OS and developer software at no cost to the student. This eliminates any licensing issues that may limit use out of the classroom.

VMs in a Hybrid Course.

At BCC, hybrid courses meet approximately half the time as traditional courses. This allows for some very creative course offerings. For example, we have recently started offering two core classes in the CIT program back-to-back on the same evening. This way, students come to campus one night and can take two courses. With a shortened class time, out of class lab practice is very important. VMs enable just that.

During the class time, the instructor will discuss the course content and highlight the more difficult topics. For lab work, the students must VMs at their house or on campus labs. The benefit in a hybrid course is the instructor can provide guidance about using VMs. The goal is not to become an expert in VMs, but rather use the technology as a tool to better enable hands-on learning of the subject matter. Experience has shown, the amount of time the instructor can spend with the students working with them in a VM environment is directly related to their success using this technology.

How do you use VMs Online?

BCC is constantly examining new and creative delivery methods for computer courses. Currently, BCC offers 31 CIT courses online. But, we do not offer any of the OS or security courses. This places a limitation on the ability of students to successfully complete a CIT degree program entirely online. BCC is actively investigating the use of VMs to address the lab participation issue.

VMs are well suited for an online course delivery method. They provide all of the benefits associated with traditional and hybrid courses and allow for students to have a hands-on experience while accommodating a flexible delivery style. But, there are many technical challenges that need to be addressed before proceeding. Students need to have computer hardware that is capable of supporting the VM software (See Appendix B for more information). In the situation of Microsoft Virtual PC, the student host OS must support Virtual PC. The VM images are between 1-3 gigabytes in size. The diversity of students with various Internet connection speeds becomes an issue in making the images available. How does the instructor get a three gigabyte

file to every student? Student Internet connect speed now becomes an issue. Also, requiring students to install software opens up the institutions help desk to a wide array of new student issues and support calls.

Solutions to some of these problems have been investigated. Since Virtual PC will not install on XP Home or Vista Premium (Microsoft 2009), standardizing on VirtualBox could be used as it does not have such limitations and it can also be installed on Macs and Linux machines. To address the large file size, books could be packaged with a DVD that contains preconfigured VMs on them that will allow an initial seeding of the students' environment. Also, a course website could be maintained with the VM images on it. The one area that has not been successfully addressed is the increase in help desk calls that are related to VMs. Admittedly, this could be pushed back on the instructor. But online courses are taught exclusively by adjuncts at BCC and instructor availability for this additional role is in question.

Conclusion

Wide availability of free virtualization applications opens up a new lab delivery tool that actively engages student learners in the course content. In an environment of decreased lab availability and an increase in the need for hands on learning, virtual machines are a valuable addition to the technology instructor's toolkit.

Appendix A

Brief Critique of Virtual PC, VMware Server and Player, and VirtualBox

The three VMs software manufactures that I commonly use are Microsoft's Virtual PC, VMware's VMware Server and Player, and Sun's VirtualBox. All three offerings are basically the same with minor advanced differences that are not needed in our course offerings. The following is a brief overview of the advantages and disadvantages of all three products.

Microsoft's Virtual PC

Microsoft's Virtual PC is the easiest of the three for novices to the VM world. It is a free download from (Microsoft 2009). Virtual PC is a windows only application, so MAC and Linux host systems need to use one of the other two offerings. Virtual PC runs all windows operating systems, win95 to Win7, with ease. With the installation of VM drivers, which are included, the student can easily navigate between the VM and the host systems. The disadvantage is that many of the popular Linux distributions require modification to run. Virtual PC does not install on Vista Premium or XP Home.

VMware's VMware Server and Player

By far the most confusing and feature rich of the three VM products. VMware Server allows the student to create VMs on their own, VMWare Player does not. VMWare Server is designed to run in a client/server environment, which most students do not have. VMWare Player is a read only product that allows students to download a preconfigured VM and run it – no VM creation allowed. VMware Server and Player can be installed on Windows and Linux host systems. VMware Player excels in providing students ability to download preconfigured Virtual Appliances, of which there are currently over 900. VMware has another product that mirrors the functionality of Virtual PC called VMware Workstation, but currently it is not freely available.

Sun's VirtualBox

VirtualBox is currently the only open source project that I use. It runs on Windows, Macs, and Linux host systems. Its feature set is more advanced than Virtual PC's and allows for greater control over the VMs. I find that Linux VMs run very well on VirtualBox, as do Microsoft OSs. However, it is more complex than Virtual PC for VM novices.

Appendix B

Hardware requirements for running VMs

In my experience, I have found the following to be acceptable conditions for running a VM.
HARD DRIVE SPACE – at least 10 GB
CPU – Minimum – Intel Pentium 4 or AMD Athlon 64
RAM:
XP Host – 500 MB
    XP VM – 500MB (per VM used, so 2 XP VMs would require 1 GB of RAM)
    Vista VM 1 GB

Linux VM 500 GB
Vista Host – 1 GB
XP VM – 500 MB
Vista VM – 1 GB
Linux VM – 500 MM

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