2021 ASEE ANNUAL CONFERENCE
Virtual Meeting | July 26–29, 2021 | Pacific Daylight Time
Paper ID #33523

Experience in Moving Information and Computer Technology Courses Online

Dr. Peng Li, East Carolina University

Experience in Moving Information and Computer Technology Courses Online

1. INTRODUCTION

The COVID-19 pandemic brought tremendous challenges to higher education institutions. Many colleges moved most or all courses online, at least temporarily. New technologies, such as high speed internet and cloud computing, make it easier to deliver courses remotely. It is expected that the share of hybrid and online courses will grow [1] with or without the pandemic. However, the pandemic is likely to accelerate the changes. The demand to move from traditional learning to online learning may be even higher in computing and information technology programs due to growing enrollment and tight resources. After the outbreak is controlled, the trend to move online probably will continue.

This paper will cover the experience in online teaching and learning in our Information and Computer Technology Programs. Strategies of converting in-person courses to online courses will be discussed.

2. MOTIVATION

Information technology operations in industry have moved from in-house to the cloud steadily over the past two decades. Since mid-2000s, we have followed the trend and converted many in-person, physical labs to online, virtual labs in our Information and Computer Technology Programs. The motivation was to fully utilize new technologies and limited resources to meet the growing demand of face-to-face (F2F) and distance education (DE) students.

Our student population was composed of about 320 in-person, F2F students and 260 online, DE students before the COVID-19 pandemic. Both F2F and DE sections were offered in many courses. In courses with a lab component, F2F and DE sections shared the same online, virtual labs but lectures were delivered differently. F2F students met in traditional classrooms while lectures in DE sections were conducted online, synchronously, or more often, asynchronously. Therefore, before the outbreak, we already had experience with online courses. We were somewhat prepared when there was a need to move F2F courses to online courses as the pandemic started in early 2020.

In spring 2020, fall 2020 and spring 2021, all undergraduate F2F courses in our department were moved online to reduce the potential spread of COVID-19 infections. For DE students, the changes in course delivery were relatively small. For many F2F students, taking all courses online was neither expected nor planned when they came to this college. Both F2F and DE students were also facing additional challenges and stressors, physically, mentally, and financially. It is important to find a way to make the online transition as seamless as possible.

3. STRATEGIES OF MOVING COURSES ONLINE

In the classes I taught, the following strategies were used when moving F2F sections online and teaching courses remotely:

- Identifying course learning outcomes
- Assigning routine activities
- Addressing difficult points
- Facilitating interactions
- Implementing virtual labs
- Providing automatic and scalable assessments

3.1 Identifying course learning outcomes

The students in F2F and DE sections of the same course should have the same learning outcomes. It is essential to define learning outcomes when developing a course. The outcomes should be assessable. The more detailed the learning outcomes are, the easier it is to convert in-person teaching to online teaching. We need to identify where the difficult points are for students to achieve the learning outcomes. In different environments, different strategies and tools may be used to address these difficult points.

To move an in-person class online, the first thing we did was re-examining the learning outcomes, including the overall course learning outcomes and chapter/lab learning outcomes. Then we adjusted activities, assessments, and resources accordingly in order to achieve these outcomes.

For example, the course learning outcomes of ICTN 4200/4201 Intrusion Detection Technologies are:

By completing this course, students will be able to

- *understand network security threats, identify malicious activities and attacks*
- *understand principal of intrusion and detection methods*
- *understand various IDS definitions, advantages and limitations*
- *know how to design and deploy IDS solutions to satisfy the actual needs*
- *understand how to handle alerts created by IDS systems and take proper responses*
- *be able to implement Snort and other IDS systems to monitor and protect from network intrusions*
- *know the current status of IDS and the future development*

Below are the learning outcomes for an individual lab – Network Intrusion Detection System Snort (III): Sensor Installation and Tuning:

After completion of this lab, students should be able to

- *set up a Snort IDS sensor*
- *set up a secure tunnel between the sensor and the central server*
- *tune the IDS by disabling/enabling detection rules*
- *use the Snort IDS sensor to detect malware traffic*

In a F2F class to be converted, if an in-person approach was used to achieve a particular learning outcome, we would search for an alternative, online approach. For example, many labs

performed on computers in a physical computer room may be moved to virtual labs online using a decentralized approach or centralized cloud approaches. More details will be discussed in section 3.5.

In another example, in-class student presentations were integral part of some F2F courses. After classes are moved online, students now create presentations using software (Mediasite Mosaic) on their own computers and upload videos to the University Mediasite server for peer review.

If no learning outcomes are clearly defined in the syllabus, it is a good idea to revisit Bloom's taxonomy and create measurable outcomes [2] before transitioning the class from face-to-face to online.

3.2 Assigning routine activities

In F2F courses, students attend lectures and/or labs routinely. Instructors often discuss activities and assignments in detail in class. In an online environment, many activities are conducted asynchronously. Some students may get lost without routine activities and clear instructions about what to expect every week.

To address these potential problems, weekly modules are created on our learning management system (LMS) Canvas. The modules contain the activities/assignments that students are expected to do each week. On Monday of every week, an announcement is posted on Canvas. The announcement details weekly assignments, activities, updates, among other things. The announcement is also sent to students via email.

In our online classes, assignments such as quizzes and labs are posted in both the weekly modules and in the Assignments folder on Canvas. If a student is ahead of the schedule, she/he can do other assignments in the Assignments folder. In assignments, we give as detailed instructions as possible. Students are required to attend the discussion board by submitting at least one or two posts every week. The discussion board is considered an extension to the online classroom and is one of several ways of student-student and student-instructor interactions.

By tracking students' participation in routine activities, it is easier to identify the ones who may fall behind and need assistance.

3.3 Addressing difficult points

It is important to identify difficult points in online learning and help students learn effectively. When moving F2F sections online, we did not simply imitate the in-person environment. For instance, unlike a F2F class with designated classroom and fixed meeting time in early mornings, it can be difficult for students in an online class to have synchronous meetings at 8 AM every day. Synchronous online lectures cannot replicate the effects and atmosphere of in-person lectures in real classrooms. Therefore, many of our online classes are delivered asynchronously.

In some courses, lectures are recorded, and students can view them at any time. However, long lecture videos are not always effective. Some students do not even have time to view them. To accomplish learning outcomes, we mainly utilize reading assignments, quizzes, hands-on labs, and online interactions. Short lectures/videos are used to address difficult points and concepts

only. There is a page of FAQs on the Canvas site of each class to cover frequently asked questions. Students also have the option to attend office hours online via Webex.

Many online tools (such as email, discussion board) support asynchronous communication, giving participants sufficient time to digest information. Text messages, with assistance of images and other multimedia tools can be understood and absorbed more easily when conveying certain difficult technical information.

The department also hires student lab workers/tutors to support open labs remotely where class participants can seek additional help.

3.4 Facilitating interactions

Effective interactions can be achieved not only in an in-person environment but also in an online environment. However, it is still challenging to manage interactions when there is a need to move in-person classes to online classes quickly.

It is important to recognize the differences between in-person interactions and online interactions and capitalize available online communication tools. In addition to the discussion board, other tools, such as Webex, Slack or Microsoft Teams, may be used for interactions.

In our online classes, meaningful student-student interactions are encouraged. Students are expected to participate in the discussion board on Canvas. For non-private issues, students are recommended to ask classmates in the discussion board first. The questions and answers can be useful to other students. Discussions unrelated to the course are discouraged.

Instructors should show up and participate in the online environment, such as the discussion board. Timely feedback is very important.

Using strategies to facilitate interactions can be as important as using new tools/technologies. For example, bonus points may be used to encourage interactions.

3.5 Implementing virtual labs

When moving F2F courses online, one of the challenges was to deliver hands-on exercises. The emergence of virtualization and cloud computing technologies facilitated our transition from the traditional physical laboratory to the online virtual laboratory. Before the pandemic, we already gradually adopted more and more virtual labs. Students log in to a virtual environment, consisting of one or more virtual machines, to perform hands-on exercises. They do not need to go to an on-campus lab at a fixed time. Students can do the virtual labs at any place and at any time. Virtualization makes it possible for students to do some labs which are otherwise unavailable in a traditional environment. In many courses with a lab component, F2F sections and DE sections shared the same virtual lab environment already, making the transition from face-to-face to online easier.

As described in papers previously [3]-[4], different virtual lab approaches were utilized, including decentralized virtual lab approach, centralized private cloud approach and centralized public cloud approach. In the decentralized lab approach, students host pre-configured virtual

environments on their own computers. They use software such as VMware Workstation, VMware Fusion, or Oracle VirtualBox to run the virtual machines. In a centralized private cloud approach, virtual environments are typically hosted on servers in a datacenter on campus. Students log in remotely to do the labs. Examples of private cloud systems we are using include VMware vCloud Director and NDG NETLAB+. In the centralized public cloud approach, virtual environments are hosted by a public cloud vendor, such as Amazon Web Services (AWS), Google Cloud Platform (GCP) or Microsoft Azure. Students log in remotely to do the labs.

The centralized private cloud approach requires resources and technical expertise which may not be available immediately when there is an urgent need to convert F2F labs to online labs. However, it is worthy of investment if there is a long-term plan to adopt virtual labs in the institution. The instructors and administrators can have more control on private cloud systems because they are typically hosted on campus. Real-time monitoring and assistance to students can be provided more easily.

Amazon, Google, Microsoft and VMware all have academic programs for higher education institutions, providing free software licenses or cloud usage credits with certain conditions. Some public cloud vendors (AWS, GCP, Azure) also provide IT-related virtual labs via online learning platforms such Qwiklabs, which can be adopted immediately. As a result, the equipment costs of setting up virtual labs in a decentralized environment or on a public cloud are not very high for individual courses. Therefore, the transition from F2F labs to online labs may be done quickly. However, the move still requires instructors and/or students to have some technical skills.

3.6 Providing automatic and scalable assessments

While timely feedback from the instructor is necessary in any class, it is especially important in online, DE classes. Many online students have family and jobs and can only dedicate limited time to learning every week. F2F students, now in online classes, may also be faced with many challenges during this pandemic. If the feedback is not provided quickly, students can easily lose track in classes. Due to widespread budget cuts, class sizes and teaching loads are increasing. It is very time-consuming for instructors to grade assignments in large, online classes. To mitigate the challenges, we have explored multiple ways of assessments which are automatic and scalable.

The idea of automatic grading and immediate feedback is not new [5]. Automatic grading systems provided by textbook publishers, can be adopted quickly. Their online learning platforms, such as Mindtap, may include some automatic grading capabilities. In the course ICTN 2732 Scripting for Information Technology, we use My Programming Lab (CodeLab) from the publisher to assign interactive programming exercises. Students submit their Python codes and receive feedback immediately. Other automated grading platforms we are evaluating include Gradescope, CodeCheck and WebCat [6].

In some non-programming, information technology labs, we developed automatic grading scripts to provide immediate feedback to students. Students run a grading script after completing a lab and receive feedback immediately [7]. They can fix errors and resubmit the work. Students can learn better with multiple attempts in a trial-and-error approach.

In some other hands-on labs, lab reports are now submitted as quizzes on Canvas. The questions with fixed answers are graded automatically. Other questions, requiring discussions and screenshots, are graded manually by the instructor or TA. This approach provides immediate feedback partially and reduces grading time greatly.

For assignments such as presentations, essays, and term papers, student peer review was used in multiple courses. Canvas already included limited peer-review capabilities which could be used immediately. Besides Canvas, we used a more powerful, rubric-based online peer review system called Expertiza [8]. In addition to peer review, Expertiza allows interactions between authors and reviewers and metareviewing of participants' reviews. After students' work is submitted, other participants, selected deliberately or randomly, can review their work. Reviewers and authors can interact using rubrics in a double-blind manner. The reviewer completes the review using a rubric with multiple questions and can add additional comments. An average score is then calculated by Expertiza.

Automatic and scalable assessments not only save instructors time for grading but also often provide immediate feedback to students, showing them where they can improve.

4. CONCLUSION

There are challenges when moving traditional courses online, especially in a short time. Many challenges can be addressed by designing courses smartly and utilizing appropriate technologies. We focused on learning outcomes, routine activities, difficult concepts, online interactions, virtual labs and scalable assessments. It is essential to take full advantage of online tools/methods, some of which may be more cost-effective than traditional in-person tools/methods. By adopting proper tools and strategies, we believe that the quality of learning in online courses can be comparable to, if not better than, that of learning in in-person courses.

REFERENCES

[1] K. Parker, L. Amanda, and K. Moore, "The digital revolution and higher education: College presidents, public differ on value of online learning," *Pew Internet & American Life Project* (2011).

[2] C. W. Starr, B. Manaris, and R. H. Stalvey, "Bloom's taxonomy revisited: specifying assessable learning objectives in computer science," *ACM SIGCSE Bulletin* 40, no. 1 (2008): 261-265.

[3] P. Li, "Exploring virtual environments in a decentralized lab," *ACM SIGITE Research in IT* 6, no. 1 (2009): 4-10.

[4] P. Li, "Virtual lab approaches for information and computer technology education," In *Online Learning for STEM Subjects: International Examples of Technologies and Pedagogies in Use*, M. Childs and R. Soetanto, Ed. Routledge, 2017, pp. 112-126.

[5] K. M. Ala-Mutka, “A survey of automated assessment approaches for programming assignments,” *Computer Science Education*, *15*(2), pp. 83-102, 2005.

[6] D. Kumar, "REFLECTIONS Tools from the education industry," *ACM Inroads* 9, no. 3, pp. 22-24, 2018.

[7] P. Li and L. Toderick, ”An Automatic Grading and Feedback System for E-Learning in Information Technology Education,” *Proceedings of 2015 ASEE Annual Conference & Exposition*, Seattle, Washington. 10.18260/p.23518.

[8] E. F. Gehringer, “Expertiza,” in *Monitoring and Assessment in Online Collaborative Environments*, IGI Global, 2010, pp. 75–96.