

Greening Data Communications and Computer Networks through the Networking Academy

Analn Niere Yumang, Glenn Ople Avendano and Geraldo Calderero Talisic

Abstract - Visual learning has been the paradigm shift for most of the courses offered in colleges and universities. Through the years, teaching Data Communications and Computer Networks has been normally done using abstract approaches, where students gripped the theories and concepts mostly with imagination and analogy.

Initially offered in the Philippines in 1998, the Cisco Networking Academy (CNA) has been a major player in revolutionizing the perspectives of education. The CNA has expanded its horizon in developing highly-effective strategies in teaching pedagogies through curriculum development, education focus and distance-learning approaches.

This paper presents the various efforts made by the Cisco Networking Academy Mapua Institute of Technology – Intramuros Campus in promoting visual learning, student-centered teaching approaches and its contribution towards carbon footprint reduction being one of Mapua's key initiatives

Index terms: Cisco Networking Academy, visual learning, Packet Tracer

I. INTRODUCTION

Cisco Networking Academy (CNA) has globally expanded its education program in constantly developing ICT skills among students in nearly 165 countries. As early as the secondary education level, students are taught how to design, build, troubleshoot and secure data and computer networks. With almost a million students completing the program every year, the Networking Academy delivers a comprehensive 21st century learning experience in equipping the students with the foundational skills needed for exploring ICT career opportunities [2].

As Cisco's corporate social responsibility, the Academy is incessantly supporting the United Nations Millenium Development Goals, Inc., in bridging the digital divide by equally promoting education opportunities for students in developing countries and as well students with impairments and disabilities [1]. Moreover, Cisco has always empowered the role of women and recognizes gender equality in all concerns of the ICT industry.

Initially offered in the Philippines in 1998, the CNA has been a major player in revolutionizing the perspectives

Manuscript received November 19, 2010. This work was supported in part by Center for Continuing Education and Special Competencies of Mapua Institute of Technology, Intramuros, Manila, Philippines. Glenn Ople Avendano is with the Electronics Engineering, Mapua Institute of Technology, Intramuros, Manila Philippines (fax: 632-524-5572; e-mail: goavendano@gmail.com).

Analn Niere Yumang is with the Computer Engineering, Mapua Institute of Technology, Intramuros, Manila Philippines (e-mail: anyumang@gmail.com).

Geraldo Calderero Talisic is with the Center for Continuing Education and Special Competencies of Mapua Institute of Technology, Intramuros, Manila, Philippines (email: gel.talisic@gmail.com)

of education. The CNA has expanded its horizon in developing highly-effective strategies in teaching pedagogies through curriculum development, education focus and distance-learning approaches. The Networking Academy is structured with online courses, interactive tools and hands-on activities to aid students in aligning students to meet career standards set by various telecommunications and IT industry [4].

Mapua Institute of Technology has been granted as the ninth Regional Academy by Cisco in the Philippines. Established in May 15, 2000, the Mapua Institute of Technology partnered with 16 local academies. To date, Mapua has already enrolled nearly 10,000 students and professionals [4]. Close to a thousand of these students have earned their Cisco Certified Network Associates (CCNA) certification, a highly-valued, widely respected IT certification recognized by industry partners and companies [3].

Since the inception of Mapua Institute of Technology as a Regional Academy, Mapua has actively participated in promoting the objectives of the Cisco Academy. The Mapua Cisco Track has been an annual winner in the National Skills Competition. Mapua developed partnership with government agencies, businesses, and other institutions to support students and alumni in their educational, entrepreneurial, and occupational endeavors. Instructors have been involved in curriculum workshops, annual conferences, trainings and retooling to continuously improve the delivery of instruction of all courses offered by the Cisco Networking Academy. Being highlighted as the sole Cisco Academy Training Center for CCNA Security in South Asia, our Mapua Cisco Academy instructors have exemplary shown their teaching skills in training academy instructors in Singapore, Indonesia and Thailand.

A. Teaching Issues on Data and Computer Networks

Data Communications and Computer Networks is a course offered to the Electronics Engineering and Computer Engineering programs. The Commission on Higher Education prescribes this course to cover data communication systems, terminals, modems, terminal control units, multiplexers, concentrators, front-end processors, common carrier service, data communication system design, computer network models, TCP/IP principles, LAN, WAN and sample case studies [12].

Generally regarded as an abstract course, delivery of teaching this course may pose challenges for new and resident instructors alike. Preparing visual aids, powerpoint presentations, flash animations, and other interesting activities to aid students in visualizing data communication

issues consumes time in the instructor's work load. Even if textbooks, reference materials and other web resources are provided, some instructors adopt other strategies to stimulate learning to their students.

Electronics Systems and Technologies (EST, formerly Communications Engineering) is one of the four areas given on today's ECE Licensure Examination. With the National Passing Percentage averaged to nearly 35%, results reveal that EST has been the cause of failure for almost all examinees who failed the board examination. Likewise, examinees affirm that questions relating to Data Communications, Computer networks, Digital Communications, Wire and Wireless Technologies to be truly challenging.

Exposure to the devices used in data communications and computer networks is vital for acquiring learning understanding. Laboratory experiences through hands-on activities and equipment configurations have proven to be crucial for a better comprehension of complex networking knowledge. Many times, students are starting to clearly grip the facts only when they are faced with real world cases in a laboratory environment with networking equipment. With many groups of students, it is often challenging to find a free timeslot in the already tight laboratory schedules. When students do not experience enough time with practical configurations, they are achieving inaccurate and sometimes worst results [6].

B. Visual Learning

Visual Learning entails the use of graphics, images and animations to enable and enhance learning in science and engineering. Visual learning is a proven method in which ideas, concepts, data and other information are associated with images and animations, while the subject is represented graphically. As an example, techniques and tools such as mind maps and animations are used in visual learning to enhance thinking and learning skills. Students can understand subjects much more easily if they can see, or even touch them in real. Visual learning uses methods that help students to open their minds and think graphically. Associations between images and some sort of information can help to better memorize and use the learned knowledge or information [6].

C. Teaching Strategies in the Delivery of Cisco Academy Courses

This paper presents the various strategies adopted by instructors in teaching Cisco Academy courses offered in the Electronics Engineering and Computer Engineering programs. Furthermore, this paper will also identify the various efforts made by the Cisco Networking Academy - Mapua Institute of Technology – Intramuros Campus in promoting visual learning, student-centered teaching approaches and its contribution towards carbon footprint reduction being one of Mapua's key initiatives.

II. EXPLORING THE CISCO EXPLORATION COURSES

A. Curriculum Guide

Networking Academy courses are delivered in multiple languages through an online learning system. Courses are supported by classroom instruction, hands-on learning activities, and online assessments that provide personalized feedback. Networking Academy instructors receive extensive training and support to help ensure a consistently-enriching learning experience for students around the world.

These courses are designed to help students prepare for entry-level career opportunities, continuing education, and globally recognized certifications. Each course is supported by classroom instruction, online assessments, hands-on labs, and interactive learning tools to help students succeed.

The Cisco Networking Academy CCNA Discovery and CCNA Exploration courses provide the experience needed to help meet the global demand for qualified ICT candidates to design, install, and manage these networks. With almost two years of offering CCNA Exploration in the Institute, the course offers a comprehensive and theoretical learning experience for analytical students, and uses language that aligns well with engineering concepts.

The curriculum is embedded with a numerous interactive activities, along with the detailed theoretical contents to emphasize critical thinking, problem solving, collaboration and application of skills in a real world environment [2].

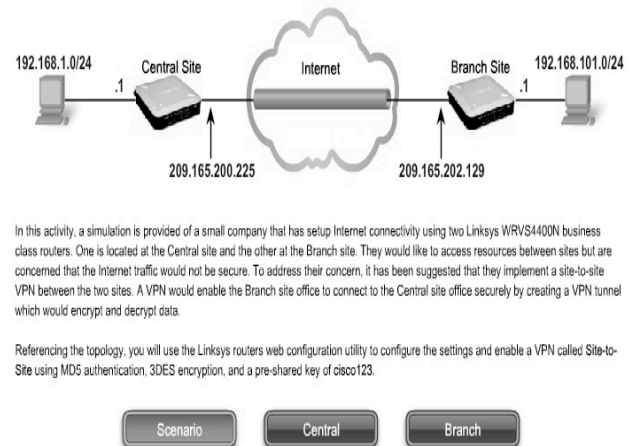


Fig. 1. Sample interactive activity embedded in the curriculum.

B. Assessments

Ordinary assessment methods are capable of measuring what students have already learned how to do, while what the educators need is to understand how students will learn to do things that they do not yet know how to do. One of the conceptualizations of this problem is the distinction between so-called summative and formative assessment. Summative assessment techniques aim at accurately evaluating the students' current level of knowledge and skills. Formative assessment offers a range of methodologies for helping students and their teachers adjust the teaching/learning process to the students' needs [8].

State-of-the-art formative and summative assessment techniques and technologies are integrated into the CCNA Exploration curricula. An online delivery system supports sophisticated assessments and complex scoring approaches. Immediate, rich feedback appropriate to the exam type supports instructor and student evaluation of knowledge and skills acquired.

Essentially, these are the forms of assessments available on the curriculum [2]:

- Interactive quizzes and testlets embedded in courses, with appropriate feedback on student responses
- Online chapter and final exams, immediately graded with personalized feedback.
- Practice exam questions that align to CCNA certification
- Skills based assessment that test the students skills and competencies on real equipment
- Packet Tracer assessments, tailored by instructors in Mapua Intramuros to prepare students for critical skills examination

C. From E-learning to E-doing

The virtual classroom meets the flexibility demands of adult learners, but educators speculate whether “e-learning” (i.e., electronic learning) achieves the traditional goals of higher education. To address this concern, some colleges and universities who offer online degrees have incorporated one or more physical face-to-face meetings between students and instructors [9].

E-doing is a design philosophy that people learn best by doing. With CCNA Exploration's e-doing activities, students remember the theories they learned, thereby solidifying basic knowledge and continuing educational

Activity

Determine how the switch forwards a frame based on the Source MAC and Destination MAC addresses and information in the switch MAC table.

Answer the questions below using the information provided.

Destination Preamble MAC	Source MAC	Length Type	Encapsulated Data	End of frame
0B	0C			

MAC Table					
Fa1	Fa2	Fa3	Fa4	Fa5	Fa6
0A		0B		0C	
Fa7	Fa8	Fa9	Fa10	Fa11	Fa12

1. Where will the switch forward the frame?

Fa1 Fa4 Fa7 Fa10

Fa2 Fa5 Fa8 Fa11

Fa3 Fa6 Fa9 Fa12

2. When the switch forwards the frame, which statement(s) are true?

Switch adds the source MAC address to the MAC table.

Frame is a broadcast frame and will be forwarded to all ports.

Frame is a unicast frame and will be sent to specific port only.

Frame is a unicast frame and will be flooded to all ports.

Frame is a unicast frame but it will be dropped at the switch.

experiences [2].

Fig. 2. Cisco Exploration e-doing activity

D. Packet Tracer

Cisco Packet Tracer is a powerful network simulation program that allows students to experiment with network behavior and ask “what if” questions. As an integral part of the Networking Academy comprehensive learning experience, Packet Tracer provides simulation, visualization, authoring, assessment, and collaboration capabilities and facilitates the teaching and learning of complex technology concepts.

Packet Tracer supplements physical equipment in the classroom by allowing students to create a network with an almost unlimited number of devices, encouraging practice, discovery, and troubleshooting. The simulation-based learning environment helps students develop 21st century skills such as decision making, creative and critical thinking, and problem solving.

Packet Tracer complements the Networking Academy curricula, allowing instructors to easily teach and demonstrate complex technical concepts and networking systems design. With Packet Tracer, instructors can customize individual or multiuser activities, providing hands-on lessons for students that offer value and relevance in their classrooms. Students can build, configure, and troubleshoot networks using virtual equipment and simulated connections, alone or in collaboration with other students. Most importantly, Packet Tracer helps students and instructors create their own virtual “network worlds” for exploration, experimentation, and explanation of networking concepts and technologies.

Cisco Packet Tracer includes the following features [2]:

- Makes teaching easier by providing a free, multiuser environment for instructors to easily teach complex technical concepts
 - Makes learning easier by providing a realistic network simulation and visualization environment
 - Provides authoring of learning activities, tasks, labs, and complex assessments
 - Supports lectures, group and individual labs, homework, assessments, case studies, games, and competitions
 - Supplements real equipment and enables extended learning opportunities beyond physical classroom limitations
- Simulates continuous real-time updates of underlying network logic and activities
- Empowers students to explore concepts, conduct experiments, and test their understanding
- Promotes social learning through a network-capable (peer-to-peer) application with opportunities for multiuser competition, remote instructor-student interactions, social networking, and gaming
- Supports the majority of protocols and technologies taught in the following Networking Academy curricula.

D. Blending Cisco Networking with Moodle

In recent years, Modular Object-Oriented Dynamic Learning Environment (Moodle) developed by an Australia teacher Martin Dougiamas has been recognized by educational field from all over the world [10]. Moodle is an Open Source Course Management System (CMS), also known as a Learning Management System (LMS) or a Virtual Learning Environment (VLE) [5]. It has become very popular among educators around the world as a tool for creating online dynamic web sites for their students. To work, it needs to be installed on a web server somewhere, either on one of your own computers or one at a web hosting company.

Apart from being free, the real power of Moodle is the sound pedagogical philosophies behind its development which aim at encouraging student centered and collaborative learning. An array of functions, such as quizzes, wiki, discussion forums, graded assignments and the like which reflect those pedagogical thought were therefore developed. Such impressive features also make it a popular platform for online course delivery [10].

III. METHODOLOGY

A. Integrating the Utilities

Mapua Institute of Technology affirms its commitment not only to its students but to all its local academies in delivering updated curriculum aligned to latest technologies. Access to the online curriculum ensures that students receive the same learning experience as that of other international Cisco networking academies. Instructors attend retooling and training session via Webex, instructor conferences and trainings to be continuously updated with curriculum, certification and other industry developments.

With the online gradebook feature available for instructors, the manner of how students are graded is customized online. The Customs Feature in the gradebook allows the instructors to modify the grading policies based on results of Focused Group Discussions.

The use of Packet Tracer in teaching Exploration courses has been a primary tool in explaining networking, routing and switching concepts in a visual environment. Doing so makes it easy for the students to associate abstract concepts in data communications. Moreover, Packet Tracer is now integrated to the Data Communications and Computer Networks Laboratory course.

Students generally complete configurations and troubleshooting activities in Packet Tracer before performing the hands-on laboratory exercises. Enforcing this practice reduces the time of the group in completing laboratory activities since the group has been exposed to simulation prior to the actual lab equipment configuration. With this setup, devices used in the Cisco Laboratory are maintained and the lifetime prolonged.

The use of Moodle integrated to the Cisco course offerings is not relatively new. Mapua-Intramuros have used this utility almost two years ago. Moodle activities have been an added feature on CCNA Certification bootcamp, to give an almost-real experience before taking the CCNA certification exam.

Recently, Moodle-based exams have been added to the Exploration courses. Instructors have tailored various types of exam questions in addition to online assessments offered in the Academy. Examination types include drag and drop, identification, matching type, true or false and multiple choice questions (single answer or multiple answers).

B. Contribution to Carbon Footprint Reduction

A carbon footprint is a measure of the impact our activities have on the environment, and in particular climate change. It relates to the amount of greenhouse gases produced in our day-to-day lives through burning fossil fuels for electricity, heating, transportation, etc. The carbon footprint is a measurement of all greenhouse gases we individually produce and has units of tons (or kg) of carbon dioxide equivalent [11].

There are ongoing deliberations on the issue of reporting carbon footprint for paper products [13]. Nevertheless, with the use of the customized gradebook available in Cisco Networking Academy, the Mapua Institute of Technology – Intramuros Campus adheres to one of Mapua's key initiatives namely carbon footprint reduction. The use of paper in all Cisco Exploration courses is relatively mitigated since all assessments, hands-on labs, Moodle and other e-doing activities can be accomplished and evaluated on a customizable gradebook available at the Academy.

C. Impact on Visual Learning

This study examined the examination results of two CCNA Exploration 1 classes enrolled on the Academy last first quarter of AY 2010-2011. These students were the first Specialization Track enlistees and were regarded as regular students in the Electronics Engineering program.

The examination was conducted on the second week of the first quarter immediately after conducting the lecture discussion on Communications over the Network. The discussion essentially described the structure of a network, function of protocols in network communications, layering architecture and addressing in network communications.

However, the delivery of the lecture for the two cases was done in a different approach. Lecture on the first class incorporated the use of Packet Tracer on discussion in visually explaining data communications issues. The traditional Powerpoint lecture was conducted for the second class. Immediately after the lecture, 25 questions were given to the two classes to validate results. In addition, students on the first group were asked if the use of Packet Tracer in the discussion helped for a clearer understanding on the topic.

Nonparametric test was performed to validate results since relatively few information can be obtained at the start of the term. Such method does not deal with specific population parameters and does not require assumptions about specific population distributions (in particular, the assumption of normality) [7].

IV. RESULTS AND DISCUSSION

Presented below is the descriptive summary of results of the scores obtained by the students on the examination given after discussion:

TABLE 1
DESCRIPTIVE STATISTICS SUMMARY

Parameters	Group I Class ^a	Group II Class
Mean	18.8095	16.0385
Median	19	16
Mode	20	18
Std. Devn	2.6479	2.7663
Skewness	-0.6559	-0.351
Minimum	12	10
1 st Quartile	18	14
3 rd Quartile	20	18
Maximum	23	22

^aLecture conducted with visual activity

Results reveal higher parameter values for the group where visual learning approach was integrated in the discussion. Even if the likelihood of normality is more evident to the second group, the group still exhibited higher variability and lower scores on the five-number summary.

Students on the first group unanimously agree that the use of Packet Tracer in the discussion helped for a clearer understanding on the topic

The Mann-Whitney U test is a test of equality of two population distributions. The test is most useful, however, in testing for equality of two population means. As such, the test is an alternative to the two-sample t test and is used when the assumption of normal population distributions is not met [7].

Inferential statistics under test showed the rejection of the null hypothesis at a 5% level of significance. In any case of directionality (whether one-tailed or two-tailed), there showed a statistical evidence to conclude that the distribution of scores for the first class was higher as compared to the second class group.

V. CONCLUSION

Incorporating visual approaches in teaching complex and abstract courses like Data Communications and Computer Networks can significantly help the students to enhance thinking and learning skills.

The use of Packet Tracer in Cisco Exploration courses as well as other Electronics Engineering and Computer Engineering courses like Data Communications and Computer Networks help students and instructors alike. Teaching and learning technologies becomes more comprehensive and more understandable if presented on environment with realistic simulation.

Skills in problem solving, troubleshooting and collaboration can be improved as students begin do Packet Tracer multiuser activities and perform laboratory activities as a group.

The Cisco Networking Academy - Mapua Institute of Technology - Intramuros Campus will continue to adhere to carbon footprint reduction one of Mapua's key initiatives.

REFERENCES

- [1] The CISCO Website. [Online]. Available: <http://www.cisco.com>
- [2] The Cisco Networking Academy Website. [Online]. Available: <http://www.cisco.com/web/learning/netacad/index.html>
- [3] The Cisco IT Certification and Career Path Website. [Online]. Available: <http://cisco.com/go/certification>
- [4] The Academy Netspace Website. [Online]. Available: <http://academynetspace.com>
- [5] The Moodle Website. [Online]. Available: <http://moodle.org>
- [6] Janitor, Josef, et al. Visual Learning Tools for Teaching/Learning Computer Networks. 2010 Sixth International Conference on Networking and Services.
- [7] Aczel-Sounderpandian. Business Statistics, 7th ed., 623-641.
- [8] Preiss, David and Sternberg, Robert. Innovations on Educational Psychology. 383-384.
- [9] Salkind, Neil. Encyclopedia on Educational Psychology. 261-263.
- [10] Mei, Li et al. Pedagogy in the Information Age: Moodle-based Blended Learning Approach. 2009 International Forum on Computer Science-Technology and Applications. 1-2.
- [11] Home of Carbon Management Website. [Online]. Available: <http://www.carbonfootprint.com>
- [12] The Mapua Institute of Technology Website. [Online]. Available: <http://www.mapua.edu.ph>
- [13] Confederation of Paper Industries Website. [Online]. Available: <http://www.paper.org.uk>



Glenn Ople Avendano is a graduate of Electronics and Communications Engineering in Mapua Institute of Technology, Manila, Philippines in 1996. He finished his Masters of Engineering, major in Computer Networks in Mapua on 2004. Currently a Cisco Certified Network Professional and a professor in the School of Electronics Engineering, he is also actively involved in the Cisco Core Council of the Philippines as Finance Officer. He has been engaged in the Cisco Networking Academy as early as 2001, continuously promoting ICT awareness and industry certification for college students.



Analyn Niere Yumang is a graduate of Computer Engineering in Mapua Institute of Technology in 2002. She pursued her graduate studies, Masters of Engineering, in the same institution and finished in 2005. Currently the program coordinator of Hewlett Packard-UNIX under Center for Continuing Education and Competencies and a professor in the School of Computer Engineering at Mapua Institute of Technology, Intramuros, Manila, Philippines.



Geraldo Calderero Talisic is a graduate of Chemical Engineering in Mapua Institute of Technology, Manila, Philippines in 1992. He finished his Master of Science in Chemical and Doctor of Philosophy in Chemical Engineering at University of the Philippines, Diliman Quezon City. He is a pioneering officer of Cisco Networking Academy Core Council of the Philippines acting as President and Chairman. He pursued Cisco Certified Academy Instructor at Nanyang Technological University.