

## Delivery of CCNA as part of a Distance Degree Programme

Nicky Moss

Faculty of Mathematics Computing and Technology  
The Open University  
Milton Keynes, United Kingdom  
n.g.moss@open.ac.uk

Andrew Smith

Faculty of Mathematics Computing and Technology  
The Open University  
Milton Keynes, United Kingdom  
a.smith@open.ac.uk

**Abstract**—This paper reports upon the success that The Open University of the United Kingdom has had in delivering the Cisco Exploration Curriculum, as an option in an undergraduate BSc degree, using a Blended Distance Learning Model. It is argued that a constructivist learning approach was taken when designing this course, which is demonstrated by this blended learning model. This is an important pedagogical distinction, as many would see the practical focus of this course as training. The importance of Supported Open Learning as a method of teaching students, and the key role of simulators, remote access tools and day schools are also discussed as contributors to the pedagogy. Bended delivery has proven to be an excellent way of delivering Cisco courses to adult learners, as supported by student feedback and attainment. Distance teaching offers the Cisco Networking Academy program an opportunity to extend reach in both existing and new markets.

**Keywords**-Cisco Networking Academy; Blended Distance Learning (BDL); Supported Open Learning; Netlab; Constructivism; CCNA; Distance Teaching; Pedagogy.

### I. INTRODUCTION

The Open University of the United Kingdom (UKOU), as a member of the Cisco Networking Academy program, delivers the Cisco curriculum to students who study on-line at home. These courses provide them with degree level qualifications and the preparation necessary to take the Cisco certification examinations, which are widely accepted as an industry standard, offering students the opportunity to gain employment in the information technology and telecommunications sector. A shortened version of this paper was presented at the IARIA conference [1] in Cancun, Mexico in March 2010.

The UKOU has been providing higher education at a distance since 1969. At the time of writing it had 180,000 [2] students studying undergraduate and postgraduate courses, mainly in the UK, but also considerable numbers in Continental Europe and some other Countries. The faculty of Mathematics Computing and Technology also has a history of providing courses relevant to employer needs. In comparison, the Cisco Networking Academy currently has 470,000 [3] registered students in 160 Countries. Just in

terms of outreach, both organizations have been successful in bringing education opportunities to very large numbers of people, and often to groups that do not have access to other types of education. Both have been successful in developing the courses and information systems to support their learners, and both provide courses that are valued by employers and employees.

The UKOU became a Cisco Networking Academy in 2003, and delivered its first CCNA (Cisco Certified Network Associate) course in 2005. Since then it has recruited more than 3000 students to study the CCNA, and is currently enrolling about 600 per year to study CCNA Exploration. The UKOU also started to deliver the CCNP (Cisco Certified Network Professional) curricula in 2009, and has already recruited 300 students to study the first CCNP modules. All UKOU students study the CCNA and CCNP using blended distance learning (BDL), or more precisely, a variation on what the University calls 'supported open learning'.

The UKOU has been a very successful University that has enjoyed growth, year on year, since it opened its virtual doors to students forty years ago. Much of the success can be attributed to the ability to offer learning opportunities to students who find it difficult to access traditional classroom based educators. For example, students in full time employment, those with family commitments at home, those in the military and those with disabilities. It is these same groups of students who have enrolled in the Cisco courses at the UKOU, and this has brought about 5% extra students to the CCNA program in the UK, at a time when the overall program appeared to have reached saturation.

This paper will expand upon the model of supported open learning (BDL) that the UKOU is using, arguing that the CCNA program is ideally suited for this form of delivery, and that BDL offers opportunities to extend the reach of the Cisco Academy Program to students in existing and new markets. Attention is also given to the experience of the students as learners, with consideration of the possible learning style being used by these courses. Specific reference is made to UKOU course T216, which delivers the CCNA.

## II. CISCO NETWORKING ACADEMY

The Cisco Networking Academy was first established in 1997 with the specific aim of helping educators to develop a sustainable way to design, maintain, troubleshoot and updates their networks [4]. In line with the original ethos Cisco still provide a complete curriculum free to schools, colleges and universities that join the academy program. All of the teaching and assessment material is provided on-line via the academy VLE. The on-line material is content rich making extensive use of animations, rich pictures, interactive quizzes and of course text. A typical page is shown in Fig. 1.

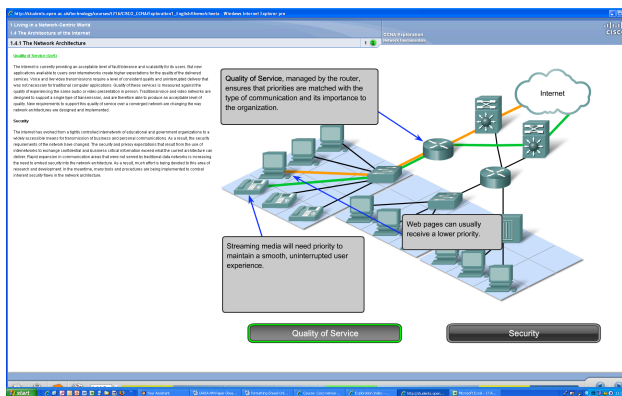


Figure 1. Example VLE page

Each page is normally divided with the text on the left and animation and other rich media on the right. Generally the text will explain an idea of concept, and the activity on the right will aim to deepen the student's understanding by engaging them. In this example a common network is used to illustrate two views, one focusing on quality of service, the other on security. Users can select either view using the active buttons, enabling them to compare the differences when applied to the same base network.

Laboratory activities are provided at the end of each chapter to enable the student's to develop understanding through a series of practical exercises. Many of these can be carried out using a simulation tool called Packet Tracer that is explained later.

There are also on-line tests and exams that allow students to assess their progress. These also provide feedback and direct students to the relevant part of the curriculum.

As well as the assessment that is built into the courses Cisco also provide a series of certification examinations that can be taken at local testing centers. Students who successfully pass these exams gain a qualification that is widely recognized by employers as they provide evidence of

networking competences that are directly relevant to the work place. Cisco CCNA and CCNP certification is highly valued in the workplace.

## III. SUPPORTED OPEN LEARNING

The style of distance learning used by the UKOU is often described as supported open learning. The key features and pedagogical aspects of this style are described below, followed by the specifics of how this style has been adapted in the case of students' studying the Cisco Networking Academy program using BDL.

### A. The UKOU Model

In the UKOU model students study at a distance, normally at home in their own time, using material provided by the University. Course related support is provided centrally by the University and by the student's own tutor. The materials the students' use for their studies can be broadly divided between teaching and assessment. Teaching materials make up the bulk, can be either electronic or print, and are often a mixture of both. Most of this material is produced in house by the University, although some third party material, such as books, journal articles, video or software is used. Teaching texts, books and DVDs are sent to the student's home, and on-line materials are accessed via the student's home page, using the usual password access controls.

The front page of the student's course home page is shown in Fig. 2.

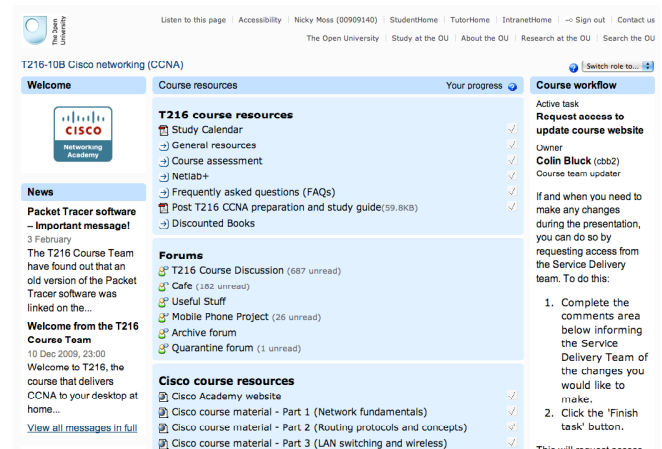


Figure 2. Student home page

The home page provides access to all of the course components, for example, a course calendar, the resource centre (library), course assessment, the academy curriculum and links to download Packet Tracer. Students can also

login to a discussion forum and follow various links to useful University wide resources via link at the top of the page. This will include formal rules about assessment or raising issues, for example.

Each group of 20 students is allocated to a dedicated tutor, who in the case of students studying the Cisco program is also a qualified Cisco instructor. Each group share a class within the academy. Tutors support the students with their study by managing the academy assessments, providing on-line and telephone support and by providing feedback when they mark each student's work.

Broadly three types of assessment are used, tutor marked assessment (TMA), computer marked assessment (CMA) and examinations. Each course will have more than one TMA or CMA and a single exam at the end.

The TMA is piece of written work that is completed by all students on the course. The work is submitted by the student to the University using an electronic handling system, and is marked by their tutor, and returned via the same system. Marked work is returned to the student with personal written feedback provided by their tutor. Marks are collected centrally for assessment purposes. The TMA provides a good opportunity for students to complete an extended piece of course work, one that tests both their theoretical grasp of the subject and their practical skills. Fig. 3 shows a network that has been used to tests students skills to plan, implement and test a network through a scenario.

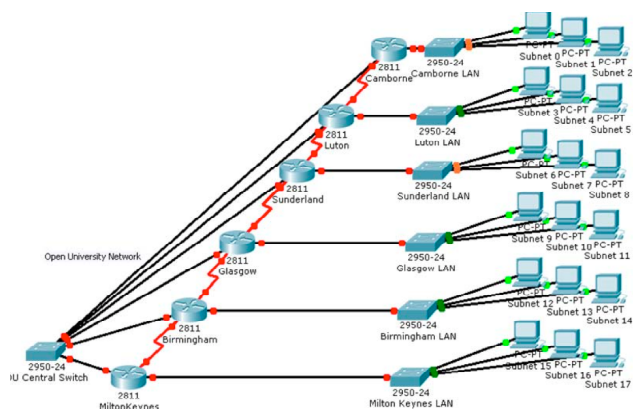


Figure 3. Network used in TMA

The network in Fig. 3 includes routers, switches and PCs. Students are provided with a scenario that states the organizations requirements and gives basic address ranges. Using this information students have to plan and configure all of the network devices and implement them using Packet Tracer. They are then required to demonstrate compliance by running various testing parameters. Their completed answer will have to be supported with written evidence to

demonstrate their thinking as well as their implementation skills. Scenarios of this type are typical of what may be encountered in a work situation and for this reason provide an excellent test of student progress.

The CMA takes the form of multiple-choice questions that are completed by the student on-line. Marks and feedback are provided to the student immediately if these are used formatively, and after a common cut off date if summative.

The final examination can take one of two forms, an extended piece of course work, which is managed as the TMA, or a formal written exam held in an examination centre local to the student's home. Students are given an overall course result once the exams have all been marked. Students are free to go on and take the Cisco certification at any time.

Guidance on studying course material is provided using an electronic calendar that provides all key dates, especially the cut-off dates for the various forms of assessment, recommended start and completion dates for individual modules and the dates for day schools. The calendar is however only a guide to student study patterns, as flexibility about how and when students study is essential for those in work or with demanding home lives. Students are provided with general study support via their university and course specific home pages. Additional course specific support is provided via on-line forum, moderated by professional teachers (tutors). Students can also call upon their tutor for support using e-mail or phone, and tutors can use their own home page to monitor their student progress and take action pro-actively.

The University also has a long history of providing stand- alone week residential schools (called summer schools) for many of its courses, especially those that are science or technology based. These are now less common, as modern on-line tools and simulations have provided good alternatives for these summer schools, even in subjects such as engineering [5]. When studying T216 students attend four separate day schools.

### B. Blended Delivery of CCNA

There are some obvious parallels between the way the CCNA curriculum is delivered through the Cisco Networking Academies and the UKOU's supported open learning model. Looking within the Cisco CCNA program for parallels, these include student home, an on-line curriculum, the use of simulation tools such as Packet Tracer, and on-line assessment, both formative and summative. The one obvious difference is that the CCNA has mostly been delivered in a classroom setting, one where

a teacher can guide students through the curriculum and labs. The experience of the UKOU suggests that classroom need not necessarily continue to be the de-facto option, although it will continue to be the dominant for most students.

Teaching the practical skills using real equipment is an essential learning outcome for the CCNA curriculum. The integrity of the final examinations is important for maintaining the credentials of the program. Maintaining both of these features is therefore critical, even if blended teaching is used. Both of these provided a challenge for the UKOU, where normal practice is for students to take much of their formative assessment at home unsupervised, and when the use of residential schools was diminishing as a result of advances in on-line labs. On the other hand, the ordered structure of the curriculum and the end of chapter tests, both fitted naturally with the flexible timetabled teaching used on other courses. Fig. 4 shows some of the assessment pages from the academy VLE.

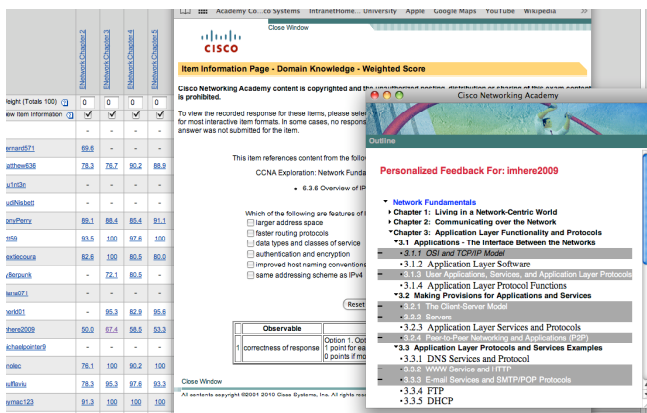


Figure 4. Assessment pages on VLE

Each student has a gradebook that shows all of their marks for the assessment taken within the academy class. The example in the background is the tutor version that shows the results for all students in that class. Students (and tutors) are able to review the results of any question taken, and see the question in full, with the answer. This is shown in the second pop up window. The feedback directing students to the curriculum areas they need to revise, based on their individual performance in a given exam, is shown in the third pop up.

This comprehensive assessment and feedback system allows students to reflect and learn from the results of their exams. As tutors can see the performance of the whole class, it also allows them to target additional teaching to areas of shared difficulty.

The final solution, that enabled the UKOU to make full use of its experience in supported open learning and meet Cisco's requirements for hands-on practical and proctored final exams were achieved with the use of dedicated day-schools and Netlab [6]. The opportunity for students to develop and practice their skills with configuring networks has also been enhanced by the rapid developments of Packet Tracer. How the UKOU has used each of these elements to deliver the CCNA Exploration curriculum is explained below.

### 1) Day Schools

Students who wish to study the CCNA Exploration courses with the UKOU can only do so as part of an undergraduate degree program. Currently all four CCNA Exploration courses are offered as a single undergraduate course titled Cisco networking, given the designated university code T216. Because this course is part of a degree program students are expected to have some prior knowledge of networking computers, their use in the workplace and basic study skills; what is termed experienced learners in the Cisco Academy.

On the understanding that our students were experienced learners, together with recognition that T216 would also include Netlab, it was agreed with the UK Cisco Networking Academy managers that there would be four days dedicated to practical skills development. As UKOU students live all over the country, it is not practical to get them to all attend one centre, so students are given a choice of dates and venues. Generally each day school follows the completion of one part of the CCNA (there are four) as this allows maximum use to be made of Packet Tracer and Netlab to prepare the students for the day, enabling them to gain maximum benefit from getting to work with real equipment.

Partnerships have been established with seven Cisco Networking Academies in the UK and one in the Republic of Ireland to deliver the four schools. This co-operation has brought benefits to both students and academies. Students can now attend day schools closer to their homes, they are taught by experienced Cisco qualified instructors, and in some of the best equipped UK academy labs. The academies have gained extra business on a Saturday, which is not a normal teaching day in the UK, allowing them to use facilities that would normally be dormant, leveraging extra benefit from the investment in networking equipment needed for teaching their normal academy students.

Students are able to book each of their day schools, from a selection of venues and dates, using an on-line booking system developed from the normal UKOU residential management system that now allows for four separate days. This system also feeds an attendance mark, necessary to



check the student meets the course requirement for compulsory day schools, to each student's assessment record. A written handbook is produced for each day school setting out the learning outcomes and activities to be carried out. This is supplied to all students and day school centers, and aims to ensure that all students gain a similar learning experience.

## 2) Netlab

The Netlab Academy Edition provides remote access to Cisco networking equipment such as routers and switches. It has been specifically designed by NDG to host Cisco training equipment on the Internet for student and instructor use, and is particularly well suited for blended distance learning [7]. It is important to remember that Netlab is not a simulator, and allows students to access the console ports of real networking equipment, such as routers and switches. Once logged into a booked session the users sees a topology such as the one shown in Fig. 5.

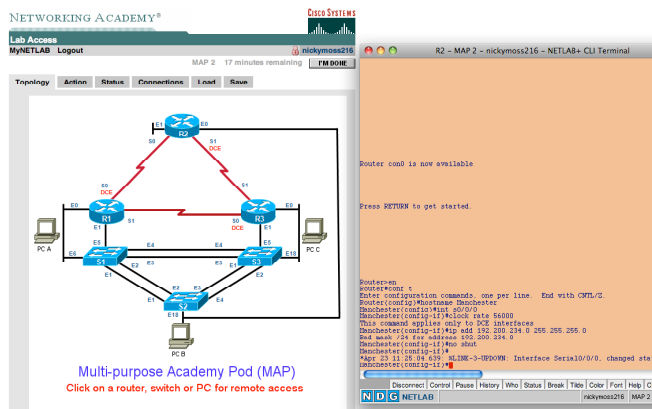


Figure 5. Netlab topology

This topology is a popular multi-purpose configuration consisting of 3 routers, 3 switches and 3 virtual PCs. This allows a wide range of scenario to be investigated by students. The right hand screen is the command line interface for one of the network devices, in this example router 1. It is this interface through, which the users set up the various devices. The script in the window is a list of commands to configure the router, and it is proficiency with the full range of Cisco commands that is one of the key learning outcomes in this program. A window can be opened for each of the nine devices shown in the topology, enabling the whole network to be configured. Netlab will save students configuration files so that they can continue with their work in another session.

All UKOU academy students are given access to Netlab for the full duration of their study, normally 9 months. Student's accounts on Netlab are organized in tutor groups

to enable tutors to monitor student use and lead teaching sessions as necessary. Some will have accounts on the UKOU's own Netlab, others will use systems belonging to our partner academies, who lease access to the UKOU. Student access is provided 24/7 using the self booking facility provided by the system.

Students can access Netlab at any time to undertake labs as specified in the curriculum, or just to practice and develop their configuration skills. All students are required to use Netlab and not to rely entirely upon Packet Tracer. Activities specific to Netlab are included in the UKOU's assessment to ensure that students complete practical work that can be assessed by their tutor and counted towards their assessment score.

## 3) Assessment

Students study the Cisco Exploration curriculum in the recommended order, starting with Network Fundamentals and finishing with Wide Area Networks. Students take all the chapter exams, normally at their own pace, although working within certain limits set by the study calendar. Their practical work is assessed at the day schools and through specific additional activities using Netlab and Packet Tracer. Each day school is scheduled to take place when all students have completed each course. For example, the first day school is at the end of the study period allocated to Network Fundamentals. Students also take their Cisco final examinations at the day school. Students who successfully graduate from each Cisco course gain the appropriate certificate and/or letter from the Cisco Academy.

The UKOU awards credit towards a BSc Hons degree to all students who complete the four Cisco Exploration courses and pass the additional assessment set by the university. This assessment consists of five assignments (TMA) taken during the course, and the final written examination. Students must also gain a satisfactory attendance for each of the four, day schools. Successful completion of this course gives the student the equivalent of 1/4 of a full years graduate study.

Each TMA is completed by all students and submitted to the same deadline. All students complete the same tasks in the TMA, which is then marked by their tutor. A range of question types are used, for example, written explanations, sub-netting calculations, Netlab activities and network design and implementation activities using Packet Tracer.

The final written examination lasts for 3 hours and draws upon the entire CCNA Exploration curriculum. Again a full range of questions are set that aim to test the students understanding, by asking them to explain, calculate and problem solve under closed book examination conditions.

The combination of Cisco Academy exams and the OU assessment provides a well-designed assessment strategy for the students. Assessment has long been seen as an essential part of teaching and learning [8], especially when it plays a vital part in getting the students to engage with the study material and keep them motivated. All students are encouraged to take the CCNA certification exams and full use is made of the preparation exams in the gradebook. Anecdotal data suggest that those that do well in the course go on and gain the certification exam.

#### 4) Supported Learning

In many respects the CCNA curriculum is ideal for students to study on their own at a distance. For example, all of the teaching material is on-line, so easily available at home or work, it has embedded simulations and activities that engage the students, it can be studied linearly without teacher direction, also Packet Tracer can be used to develop practical skills and there is assessment with feedback, which allows students to assess their own progress.

Unfortunately, providing students with easy on-line access to good study materials, with optional access to tools and assessment does not often lead to successful study. Technology alone is not sufficient [9], and students benefit immensely from a learning environment that offers support and fosters ambition to learn.

A central feature of the UKOU's supported open learning model is the role of the tutor (associate lecturer). Each student is assigned to a tutor group, nominally with 19 other students. Tutor groups are based on the student's geographical location, and this allows for face-to-face meetings, although these are not central to the teaching model. Tutors will make early contact with their students using e-mail or telephone. Students will also receive their login information for the academy, login detail to their OU home page and a welcome letter from the chair of T216. Together these contacts should give the student a sense of belonging, in some ways similar to their first day at a conventional college. Students will also have contact details for their tutor on their home page, and are free to contact her if they have any queries.

During the first two weeks of the course students are allowed time to explore the UKOU learning resources and familiarize themselves with the academy site and materials. Additional study materials have been produced to assist the students in getting to grips with the basics of the academy gradebook and Netlab. A local face-to-face session is also arranged where each tutor can meet their students and go through all of the on-line learning materials and tools. Very few students have any difficulty in getting on with studying the course once they have reached this point.

Additional study support is provided through a national on-line forum. This is open to all students studying the course, and is primarily intended as self-help, where students are encouraged to exchange ideas, ask each other questions, and generally build up a sense of belonging to the UKOU and the Cisco Networking Academy. The forum is moderated by tutors, who provide an input to discussions when necessary, perhaps to correct a thread started by a student that is re-enforcing misinterpretation, or just giving wrong information. They also ensure, through a light touch that students behave appropriately in their exchanges with other members of this on-line community, an example of an exchange is shown in Fig. 6.

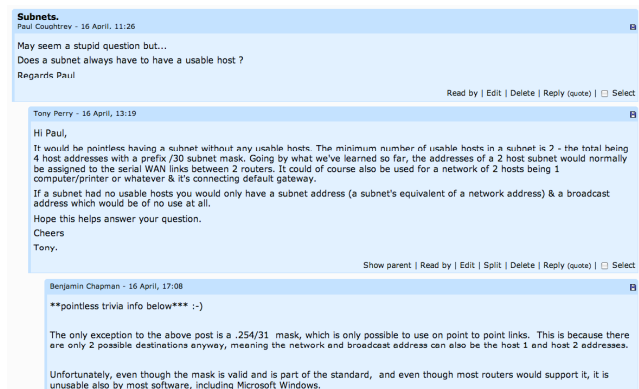


Figure 6. Forum discussion

This is a good example of a thread where one student is asking a question and other students are providing the answer. This self-help benefits all students - the one that asked the question because he gets a quick answer, within 2 hours in this case; the students that provide the feedback as they are rehearsing and developing their own understanding by putting it in their own words; and the many students who were stuck on the same point but had not asked. This is an example of a short thread, and there are many that extend to 20 or more replies. Moderators regularly review the forum, mainly to make sure that no thread is developing in a way that would be misleading to the students, but also to answer more specific questions such as clarification for assignment questions. By using the forum for this type of interchange between tutor and student all benefit from the answer and not just the one that asked.

All tutors are also trained academy instructors, and each one has an academy class with the same membership as their tutor group. This means that each tutor can see the progress of their students by checking their chapter exams in the academy gradebook. The tutor's own home page on the UKOU site also has the progression and assessment particular to the university study path. This information allows tutors to be pro-active in supporting their students if they are falling behind, or having other difficulties with

their studies. Tools on their homepage also allow tutors to send e-mails to all or some of their students as they choose. This provides a very easy means of contacting groups of students, for example, a sub-group that all had difficulty with a particular set of questions in an end test.

Students have to submit a TMA about every six weeks. This process establishes a dialogue between each student and their tutor that is particular to that student at that time. The student's performance in the TMA will give the tutor a clear idea of how he is progressing. This will allow the tutor to tailor the feedback to the needs of that student. Some examples of feedback include explanation of sub-netting, or the suggestion to try a lab again, or perhaps just reassuring the student that they are coping with the course, or explaining what might happen at a day school if they express some anxiety.

There is good synergy between the Cisco Networking Academy and the UKOU as all tutors are also qualified Academy Instructors, and many of these also teach at day schools. As a result of this partnership the UKOU now employs more than 30 academy instructors on a part time basis, and role that most see as an enhancement to their CVs.

Following the success of delivering the Cisco Academy, as distance learning courses at undergraduate and post graduate level, the UKOU has started to include material from other vendors in our degrees. Vendor related courses being delivered, or planned to start soon, include Linux, Microsoft and VMware.

##### 5) Packet Tracer

Packet Tracer provides students and teachers with a vast range of learning opportunities, from helping students to learn the basics of configuring routers, through to the design, implementation and fault finding of complex internetworks. The UKOU has used Packet Tracer extensively, both by actively encouraging students to attempt all of the labs, and by including scenarios as part of the TMA assessment as described earlier.

Packet Tracer is a very powerful simulation tool that enables users to build, configure and test many types of networks from one containing only two devices joined by a single cable, through extensive networks containing many different types of devices and connection types and finally networks containing many sub-networks. Perhaps the limit is only the imagination of the user.

An example screen taken from Packet Tracer is shown in Fig. 7.

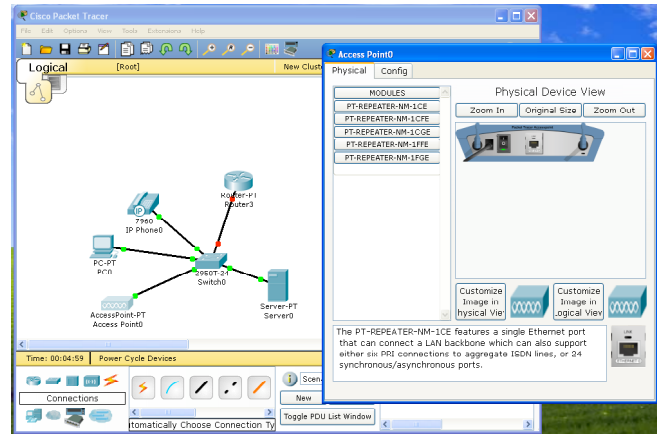


Figure 7. Packet Tracer screen

A network layout is shown on the left hand side of the figure is easily constructed by the user dragging the appropriate icons onto the screen and joining them with the appropriate connection types. In this example a router, switch, server, wireless access point and an IP phone are shown, variously connected using serial or twisted pair cables. Once a device is put on the desktop it can be accessed by a window that gives access to the command line interface and other choices. In the figure a physical representation of the device is shown. This allows the user to carry out function such as power on or off. This may at first seem a little artificial, but actually replicates the requirement in the real world of taking account whether equipment is powered before connecting or disconnecting cables. There is also a rear view of the device, which is important as recognizing a device from the rear is necessary when making connections. Packet Tracer also has an advanced facility for tracing data packets through the network, allowing users to analyse protocols at different points in their travel across the network.

It is important to fully appreciate how powerful a learning tool Packet Tracer is. While it is a simulator it does support the full command line for many devices and therefore offers students a very real experience when building networks. This effectively gives students the opportunity to build networks that would cost many thousands of dollars using real devices, and explore scenarios that would only normally be within the scope of the largest networking companies.

#### IV. STUDENT LEARNING

Having looked at the essential elements that are available to the students to learn about networking and seeing how these are combined into a blended distance learning package, it is important to consider how this blended delivery of the CCNA can be understood in terms

of learning theory. For example, is the pedagogy predominantly instruction based, that is where student's mainly focus on what is presented to them, checking their understanding through tests that confirm whether they got the right or wrong answer. Or is there evidence of deeper learning, where students engage with the learning materials in a way that enables them to reflect upon the goal and their action in working towards it.

It will be argued that the latter is the case, and that there is evidence of deeper learning that may be explained in terms of constructivism [10]. There is also evidence of socio-cultural learning through forum and collaborative learning, primarily at day schools.

It is equally important to find out how the students view the learning experience and how well are they think they are learning? In this respect student feedback can confirm, or provide contrary evidence, that they are learning at a deeper level, although it is unlikely that students would express their experience in terms of learning theories, but they are likely to use the kinds of language that can be associated with a particular theory.

#### A. Learning Theory

The CCNA curriculum uses a media rich presentation of the learning materials together with self-assessment activities and end of module on-line multiple-choice examinations with personal feedback. The UKOU also provides additional teaching material and assessment in the form of written tutor marked assignments. In summary these can be divided into two classes, on-line study materials and assessment. In addition to these teaching and assessment material there are also practical activities in the form of labs, some embedded in the curriculum and others associated with assessment. There are also the intensive day schools and supported learning provided by tutors and the forum. The division of study time between learning materials, assessment and labs is approximately even, that is 1/3 of the available time on each. Although a distinction is drawn between the different classes of activity it is important to recognize that the essence behind supported learning is to make sure that all of the activities are integrated together, and it is the context of the overall course that learning should be judged.

In the context of learning the key question is whether learning is what is termed surface or deep. In the former the student's understanding is typified by rote learning, with success being measured by them knowing the correct answers to questions that they encounter in the course of their study. This can be referred to as instuctionalism, where the priority is for the teacher to deliver and correct the students. In the latter a deeper understanding is achieved by

engaging the student actively in the goal and feedback path so that they can not only judge right and wrong, but also see how they can work towards the goal. This process leads to students who can apply what they have learned to novel situations, for example. In some ways more importantly, they actually learn to learn for themselves.

Constructivism is a theory that can be traced back to Piaget [11], although there has been significant development in thinking about this topic since [12], including the application of the theory to distance learning as well as the more conventional face-to-face situation. Constructivism proposes that learning is achieved through the forming and modification of internal mental representations, and in this context encourages teaching to focus in a way that draws on various cognitive processes that underlie learning. Significantly, this approach allow learners to accommodate their new learning into the context of their existing view of the subject, or even more broadly into their general view of the world, which is particularly pertinent if their newly acquired learning is to be applied in the workplace. A central tenet of constructivism is to get students to take responsibility for their learning, what is termed active learning. This requires a shift in the role of the teacher towards facilitation.

It has been argued [13] that a teaching approach based upon constructivism alone may not be the most effective, that the transmission of knowledge is still a key overall part of learning. The authors' believe that the components of this BDL model provide this balance between giving the necessary knowledge and providing them with the tools for the cognitive integration of this knowledge. For example, the on-line curriculum sets out the basic knowledge for student to build upon and creative assessment, with feedback, informs students whether they are gaining a deep or shallow understanding. For example, the feedback on the multiple choice questions in the Cisco academy allows students to try the question again before giving them the answer. It also directs them to the relevant learning material so that they can revise a topic to see where they have gone wrong. The tutor marked assignments, provided by the UKOU, set challenging practical based scenarios, where written individual feedback is provided with the specific aim of helping students understand where they have gone wrong, not just correcting their answer. A certain percentage of the feedback given is of a type called feed-forward, which is more general and specifically aims to help students with general learning that they can apply to future assignments.

The taking of labs, using packet tracer or Netlab, challenge students and build their confidence, as they put the knowledge they have gained from the curriculum into practice. One of the key features of the labs is the extensive practice using the command line interface. Students need to



become fluent with a wide range of commands that enable them to configure various networking devices such as routers, switches and servers. Configuring a network is not simply a matter of following a menu, the choice of routing protocol, addresses and other network parameters needs to be worked out before choosing a particular sequence of commands to achieve the planned aim. If an error is made it is then necessary to carry out detailed fault finding diagnostics to identify the error and take corrective action. It is this combination of using knowledge, planning, implementing and testing that take students repeatedly through the loop between the task, their conception of the task and the learnt concepts that develops their deep understanding. It is this combination of theory and practice that allows the claim that a constructivist learning is taking place.

On-line forum allow students to exchange ideas and support each other, and day school activities are organized around group activities. These two provide opportunities for the social and co-operative aspects of learning. Tutors and conference moderators take on the role of a facilitator as they guide student discussion within the forum and help them to clarify their thinking when they are experiencing difficulty with some aspect of learning or doing labs. The challenging network scenarios in TMAs push students to consolidate their learning in the context of real network design problems. Overall, this combination of components ensures that independent learners become successful in achieving the learning outcomes of the course.

More work is required to fully understand and support the claim that courses like this one, courses that have an emphasis upon the development of practical skills, lead to deep learning because the underlying pedagogy is constructivist. In fact many educators may well be surprised, and even disagree, with this argument, as many have dismissed the CCNA as training, and therefore not really fit for inclusion in a degree program at all. The emphasis upon training would definitely point towards instructionism as the underlying pedagogy. The point, which a crude classification between training and education misses, is the level of knowledge that is needed to carry out some of the practical activities and the recognition that situating these activities in real world examples enhances the students ability to recall and use their knowledge in other real world situations, exactly the goal of constructivism.

#### B. Student Achievement and Feedback

Students were surveyed during the 2008 presentations of T216, and 71 students responded. The statements in table I compare student satisfaction with the normal for all level 2 ICT (information communication technologies) courses.

TABLE I. STUDENT SATISFACTION

Student Satisfaction Question	T216	ICT
Overall, I am satisfied with the quality of the course.	94.4%	88.8%
The course met its stated learning outcomes.	97.1%	88.5%
I enjoyed studying this course.	91.6%	81.2%
The workload on this course was higher than I expected	66.2%	37.9%
I would recommend this course to other students	91.6%	82.1%

As can be seen from the first three entries in table I, students rated the course very highly in terms of their satisfaction with quality of the course (94.4%), the fact that it met the stated learning outcomes (97.1%) and that they enjoyed their study (91.6%). These are very good scores, especially when set against the fact that the UKOU is one of the highest rated Universities in the UK in terms of student satisfaction.

The fourth entry in the table did show a higher percentage (66.2%) of students who stated that the workload was higher than they expected. Discussions in the forum suggest that this may be because of two reasons. First, because of the frequent formative assessment, students are continually checking their understanding and reviewing topics where they have not gained a high score in the exam. Second, because of the very large number of labs that must be completed if students are to become proficient with the practical skills. Although rated with a higher workload, overall student performance is good, with many students gaining high marks.

Perhaps the last entry is the most significant, with 91.6% of students saying that they would recommend this course to a friend.

During the survey students were also asked to make their own comments. These were then collated and other students were asked to respond, either as agreeing or not agreeing with the statement of another. Table II show student's ratings for statements generated by other students.

TABLE II. STUDENT RATINGS

Student Question	Response
TMAs and continual assessments were essential to keep studies on track.	Mostly agree.
The simulation software Packet Tracer was excellent.	Definitely agree.
The combination of Cisco Academy material with OU's support material and assessments worked very well for me.	Definitely agree.

The responses to statements generated by other students are very insightful as it states what is important to them, rather than asking what is important to the teacher or the institution. Definitely agree is the highest endorsement that

student's can give, and they valued the general approach taken by the UKOU, that is a combination of Cisco and OU teaching and assessment. The success of this approach is further endorsed by support for packet tracer and the day schools. It can be seen that not every student agreed that assessment was essential to keeping on track with their study, but that is not surprising as few really look forward to assessment even if it does enhance their learning overall.

Perhaps the best overall feedback is the type shown in table III, sent unsolicited from a student at the end of 2009.

TABLE III. STUDENT FEEDBACK

By passing the course I managed to pick up a degree and a new job - yipee. No longer am I a technician in the Royal navy but now working in industrial networking for a company called GarrettCom - they manufacture industrial strength switches, routers and media converters. The networking theory is the same but the command lines are different. Hopefully I can find the time to start CCNP next year.

This student's comments neatly summarise the strength of the Cisco CCNA when combined with distance learning. This student has had a full career in the navy and has prepared for the day that he has to leave by studying towards a degree with the UKOU. His success is testimony to the flexibility of this study method, as it cannot be easy for a full time member of the armed forces. His choice to complete his degree with the CCNA has provided him with both the academic qualifications and the skills to start a new career in networking.

Overall, students are successful with their study of UKOU course T216, with most completing all four Exploration modules and passing the final exam. These students generally also go on to take the UKOU examination and gain credit towards their University study. Based upon anecdotal evidence from the student forum, a significant number go on to take the CCNA certification. Some claimed to have passed with a mark of 100%.

Students who study with the UKOU are adults (over 18 years), and more than 75% on T216 are over 25 years. Most are studying to further their careers. These factors give this group a high level of motivation, and they may do better with this type of learning than other groups.

## V. CONCLUSION

The decision taken by the UKOU to offer the CCNA curriculum as a blended distance course has been rewarded with high student numbers and good student feedback. This success has shown that this model of delivery is well suited for adult learners, and may well be suited to all learners. It must however be recognized that BDL involves much more than just enrolling students and offering them access to the Cisco curriculum. It is vital to

support learners in a way that facilitates learning, and to make maximum use of Packet Tracer and Netlab to develop student's practical skills. Day schools are also essential as they give students the chance to get their hands on real equipment. Overall, it is the management of the students and resources, in a way that facilitates active learning, that lead to successful students. On-line forum, good information systems and tutor support all play an important role in this management. A well planned and managed BDL form of the Cisco Academy Program offers an opportunity for educators to reach new students in established and developing markets.

Some arguments have also been put forward that a course that focuses on teaching practical skills as well as knowledge does engage students in deep learning. Particularly, that the pedagogy that underpins this course is constructionist. A conclusion that may surprise many educators who have tended to draw a line between education and training, and may have neglected to give credit for the situated nature of practical learning and hence its contribution to the overall learning of the student.

The UKOU looks forward to building upon the success of the CCNA as they move forward with a Masters qualification built around the blended delivery of CCNP.

## ACKNOWLEDGEMENT

The authors would like to thank the many people who have worked with them in establishing and running this BDL version of CCNA. They are too numerous to mention individually, but include people from Cisco UK, CLI, the UKOU, the UK central academy and our other day school partners.

## REFERENCES

- [1] Moss, N. and Smith, A. (2010). Large Scale Delivery of Cisco Networking Academy Program by Blended Distance Learning. LMPCNA 2010, March 7-13, 2010 – Cancun Mexico.
- [2] The Open University. <http://www3.open.ac.uk/about/> Accessed on 22/12/10.
- [3] Cisco Networking Academy. <http://www.netaced.net> Accessed on 22/12/10.
- [4] Hernandez-Ramos, P et al. (2000). Changing the Way We Learn: How Cisco Systems is Doing It. International Workshop on Advanced Learning Technologies, December 4 – 6 Palmerston North, New Zealand
- [5] Bissell, C.C. and Endean, M. (2007). Meeting the growing demand for engineers and their educators: the potential for open and distance learning. Meeting the Growing Demands for Engineers and Their Educators 2010-2020, Munich, Germany, 9-11 November 2007.
- [6] NDG. <http://www.netdevgroup.com/home.htm> Accessed on 22/12/10.
- [7] Prieto-Blázquez, J. et al. (2008). An Integrated Structure for a Virtual Networking Laboratory. In *IEEE transactions on Industrial Electronics*, Vol 55, no 6, pp 2334-2342

- [8] Papert, S. (1991). Situating constructivism. In Harel I & Papal S (Eds.), *Constructivism: research reports and essays, 1985-1990* (pp 1-11). Norwood, N.J: Ablex Publishing Corporation.
- [9] Heap, N.W., Kear. K.L. and Bissell. C.C. (2004) An overview of ICT-based assessment for engineering education. *European Journal of Engineering Education*, Vol 29, no 2, pp 241-250.
- [10] Laurillard, D. (2002) *Rethinking University Teaching: a framework for the effective use of educational technology* (2<sup>nd</sup> edition) London, Routledge Falmer.
- [11] Piaget, J. (1978). *Success and Understanding*. London: Routledge & Kegan.
- [12] Brophy, J. (2002). *Social Constructivist Teaching: Affordances and Constraints*. Oxford: Elsevier Science.
- [13] Laurillard, D. (2009). The pedagogical challenges to collaborative technologies. *Computer-Supported Collaborative Learning* (2009) 4:5–20.