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eLearning Experiences in Work for Training Courses for ICT Skill Certification

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Abstract: In this paper we describe experiences and challenges met in developing global training courses for ICT skill certification. The course development is based on two EU-funded projects. The projects are entitled International Certificates of Excellence in Selected Areas of ICT (InCert) and Vocational Training for Certification in ICT (Train2Cert). The InCert project strives towards automated vendor-neutral certification of ICT skills. In the Train2Cert project we have developed online training courses as preparation for the ICT certifications. The certifications and training courses cover hot subjects of ICT, such as wireless systems, mobile phone systems 3G and 4G, Internet protocols, WWW technologies, signal processing in telecommunication transmitters and receivers, optical networks, as well as information and network security. The paper also encourages discussion towards wide acknowledgement of global ICT certifications and training.

Introduction

Currently, the increase in Information and Communication Technologies (ICT) innovations, their diffusion and applications need both multi-level technological and also knowledge and competence based competition. Both ICT providers and end-user companies need workforces able to develop and manage ICT tools and to understand, build and manage the new ICT-related business. Moreover, considering the shortness of ICT life-cycles, the risk of rapid skills obsolescence is extremely high. (Capra & Marinoni 2006)

In this scenario, the labor market is forced to face ICT skills gap and mismatch. Certifications and qualifications may fill that gap. Certification is a credential evaluation process whereby an individual's knowledge and/or skill in a particular subject area is verified against a set of predetermined skills standard by means of an objective assessment. Certifications are credentials that provide formal verification that an individual has met a set of predetermined skill standards relevant to a particular role. (Capra & Marinoni 2006; CompTIA 2004)

This paper is based on work done in two EU-funded projects. The projects are *International Certificates of Excellence in Selected Areas of ICT* (InCert 2008), and *Vocational Training for Certification in ICT* (Train2Cert 2008). The former one is called InCert for shortness. The latter one is called Train2Cert. At the time of writing (September 2008) there are still five months to the completion of the projects.

The InCert strives towards automated vendor-neutral certification of ICT skills. In the InCert project a set of international certificates, focused on the hot subjects of ICT (e.g. wireless systems, mobile phone systems 3G and 4G, Internet protocols, WWW technologies, signal processing in telecommunication transmitters and receivers, optical networks, as well as information and network security), are developed and tested. To get the certification it is highly recommended to participate in a dedicated training course. In the Train2Cert project, vocational global training courses for ICT skill certifications are created. The courses cover most of the InCert certifications. In the InCert and Train2Cert projects, there are altogether 10 partner institutions. Majority of them are universities and research institutes. Also training and other organizations involved in the ICT sector are working for the projects.

In this paper experiences met in global training course development for ICT skill certification are described. At first the innovative nature of work is described. That is followed by a section in which the conduct of experiences and analysis of ICT usage is discussed. The section includes descriptions on issues related to training towards certifications. Issues cover selected characteristics of web-based self-learning, as well as tutor guided virtual and physical laboratories. Especially the grounds and advantages of different laboratory approaches are covered. At the final section the findings, lessons learnt, as well as the future tasks and possibilities are discussed.

Innovative Nature in Generation of Global Training Courses for ICT Skill Certification

Nowadays the concept of learning is widening its meaning, including a more and more relevant component of experience. This evolution moves the attention from the simple 'know something' to the 'know how', and that is why also training is becoming a major component of the skills required in eLearning.

The certification of skills is an effective way to boost ones value in global labor markets. To get the certification it is highly recommended to participate in a dedicated training course. To enable global offering of these courses, it was designed to strive towards easily transferrable course material, implementation, and instructions for these two. In practice this meant division of each course to two components: the self-learning part and the tutor learning part.

The self-learning part consists purely of easily transferrable eLearning content. All self-learning materials created in the Train2Cert project include interactive elements. The main goal for the self-learning part is to prepare the candidates for the certification exam. The certification exam consists of multiple choice questions (MCQs) and in some certifications also a separate laboratory test. An effective way of preparation is to practice with test MCQs that are highly similar to those that are faced in the actual certification exam. Each module in the self-learning parts includes a self-evaluation section that enables candidates to test how well they have understood the core content, and at the same time learn the answer strategies and procedures needed in the certification exam. On the other hand, the laboratory training offered by the Train2Cert courses is very efficient practice to the possible laboratory test of the certification exam.

Another, mostly technical characteristic of selected self-learning parts is the compliancy to the World Wide Web Consortium's (W3C) recommendations (W3C 2008). Although such requirement is commonly used in many national training course programmes and projects, we are not aware of such compliancy decisions made in a global scope.

The tutor led parts of all Train2Cert courses support active learning and offer practical hands-on experience to the candidates. The tutor led parts are implemented with exercises in a physical or in a virtual laboratory. Both implementation methods have their own advantages and disadvantages, which are discussed in more details in the following sections.

Conduct of the Experiences and Analysis of ICT Usages

Self-learning Part

In this subsection some aspects that influenced to the realization of the self-learning parts are discussed. The rationale of teaching methods is described. Some components to support active learning and also some technical opportunities and challenges in implementation are discussed.

Although there are some relevantly static elements that follow the information transfer principles by nature in the materials created within the project, all self-learning materials include interactive elements. Due to limited resources and different teaching cultures already among project partners, the selected approach was seen as a necessary compromise to enable global use of the material. While the goal of the Train2Cert courses is mainly to prepare for certification exams, especially MCQ tests were seen as a useful interactive element.

All interactions were implemented on the client side (e.g. with JavaScript), and hence the actual webification process was substantially simplified. The global scope made it important that the self-learning material is accessible regardless of user's operating system or browser preference. We saw following the W3C's recommendations as the best solution to guarantee the technical usability and accessibility of the materials.

Most project partners that were developing the self-learning part, decided to webify the content with open source tools. In practice merely intelligent text editors, such as Notepad++ (Notepad++ 2008), were needed. Although we were not experts in XHTML or CSS, it took only a few intensive days to learn the concepts and sufficient usage skills to be able to produce material in W3C's recommended format. For the short learning period the resources of W3Schools (W3Schools 2008) were considered especially useful. As tools and resources were free of charge, the selection turned out to be efficient also from the economical point of view.

Virtual Laboratory Training

In this subsection we focus our attention on practice in eLearning. The approach used in the Train2Cert project can be defined 'blended' as parts of the courses are expected to be offered also in the traditional face-to-face way: these parts (tutored parts) mostly consist of training laboratories. But in ICT sector, setting up a real laboratory often means facing three main issues.

Firstly, setting up a real laboratory would imply to handle a big initial payout due to the number of needed appliances (e.g. mobile equipment, SIP clients, etc.) and / or even the high price of a single appliance (e.g. optical equipment). Secondly, from an international distribution point of view, the laboratory should be easily duplicable in multiple seats. Lastly, every seat should have the staff able to deploy and maintain a fully working real laboratory. Even in the case of having that staff, we should think how to bear the potential costs. A good observation is that all these issues deal with excessive potential expenditures, which are often not affordable.

For these reasons, we think that in the ICT sector an optimal compromise is the concept of virtual laboratory. By that we mean a software that allows similar interactions as the physical laboratory, by simulating some peculiar characteristics of real equipments. Doing so we just transfer the problem of the cost on only one heading, the software, which is hopefully more manageable.

In development of the Train2Cert Optical Networks course, which prepares the candidates to the InCert Optical Networks Professional (ICONP) certification, the first obstacle was the lack of existing software for our purpose. The first obstacle was mostly caused by the high level of specialization required in the optical field. At the best of our knowledge no training software of this type and / or on this topic exists. In ICT sector, the CISCO web academy is famous for its simulation software named Packet Tracer (PT) (Packet Tracer 2008); however there are strong differences between the two solutions, e.g. the PT is not neutral at all since it emulates only CISCO appliances and it is focused on pure electronic devices. The lack of existing software was a serious issue but at the same time gave us the possibility of being the first to offer training software on optical networks. So we decided to develop it by our own.

In the early stages of the project this problem could be seen as a software engineering problem, as we had to take decision about requirements and design, planning testing and maintenance. Since the limited amount of resources of the project we decided to focus only on those aspects that could enrich some contents of a further 'aesthetic' appeal and thus helping the memorization process, e.g. animation on different re-routing techniques after link failures.

We wrote the software based on an open-source approach, using OMNeT++ (OMNeT++ 2008) libraries freely available for educational purpose. It is our intention to offer under Academic Public License (APL) both compiled and source codes: in this way the installation on any platform should be possible. The use of the software is twofold. Firstly, it can show the correct working of a system both by importing external configuration files and by cascading menus. Secondly, the student can be asked to set up a certain system configuration and the software is able to assess the correctness of his / her solution. The output in case of a successful setting is shown in Figure 1.

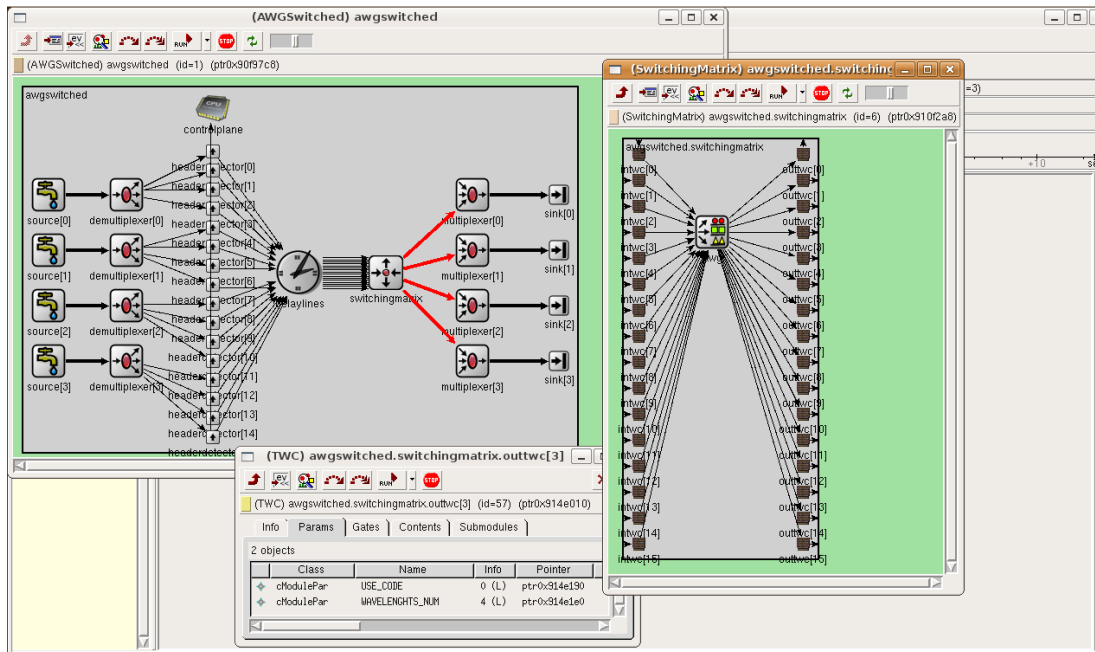


Figure 1. Screenshot of the software GUI. It exploits OMNeT++ libraries to give a deep access to modules and functional parameters.

Although some abstraction from the strictly optical physical layer, we think that the virtual laboratories can still help the student to achieve the learning goals: Awareness that errors can occur (no need to panic); Operating environments are complex as they are the combination of different interacting systems; Scaling of the complexity. The use of simulation in groups or in presence of a laboratory tutor allowed a more critical approach to the experience.

Physical Laboratory Training

In this subsection some aspects, which influenced to the realization of physical laboratories in a global scope, are discussed. The key elements relate especially to the device requirements (hardware and software), their availability in training organizations, and compromises that had to be made to reach consensus between these two. The subsection concentrates on the creation of the network security laboratory which is part of the training course that is recommended preparation for the InCert Network Security Professional (INSP) certification. The emphasis is on issues that were made to reach consensus at a global scope.

The tutor led part of the network security Train2Cert course is implemented in physical laboratories. Although physical laboratories are not globally as easily transferable as virtual ones, there is a solid ground in use of physical environment in network security exercises. The ground consists of aim to provide real-life hands-on experience on devices related to network security, and on the lack of suitable existing virtual environments.

Based on our experiences, the real-life hands-on experiment is irreplaceable to reach the learning goals in network security courses. Especially the design of network security is truly understood not sooner than when actually implementing the design. In fact, network security design is sometimes compared to software development (Welch, Ragsdale & Schepens 2001) due to their similar nature of design.

Another significant reason for selecting a physical laboratory instead of a virtual one was the fact, that there were no versatile virtual environments or software available to adequately simulate the required environment. The current solutions, such reported e.g. in (Border 2007; Bullers, Burd & Seazzu 2006; Hu & Meinel 2004; Summers, Bhagyavati & Martin 2005; Walden 2005; Wang & Yetsko 2005), concentrate on simulating a small separated task or offer physical laboratories via remote connection. We are not aware of an environment that would simulate both the network devices and relevant software. Moreover, project resources

did not enable the creation of such environment. Thus the only plausible solution was to use actual physical laboratory.

Due to the project requirement of transferable laboratories, the actual laboratory had to be designed in such way that it would be possible to utilize the same design everywhere. In practice this meant the use of as low cost and as generic hardware as possible. The network security laboratory at the author's university consists of hardware firewalls, routers, switches, and e.g. multiple virtualized systems in desktop PCs. However, for Train2Cert course, a simplified version of this was designed. With careful design, the minimum hardware requirement for the simplified version was something that could be utilized in most training organizations worldwide.

The simplifications led to minimum configuration of one router, one switch and four low cost desktop PCs with a Linux operating system. Although the hands-on experiment of configuring hardware firewalls, as well as securing larger networks were left out from the Train2Cert course, most of the core learning goals were transferable also to the global course. In practice this meant e.g. replacing the hardware firewall with router's access lists. The logical layer example of the minimum configuration is illustrated in Figure 2.

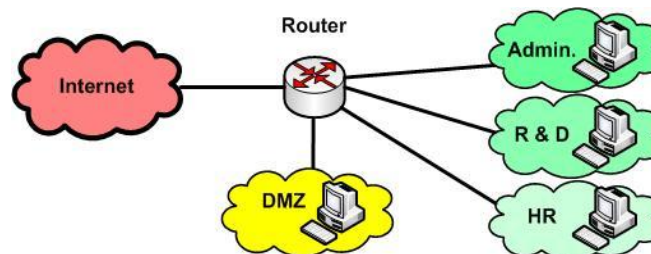


Figure 2: Example of logical layer minimum configuration.

Although such simplifications may seem destructive from learning point of view, we believe that while the core learning objectives can still be reached, the simplifications were justified to enable organizing of such courses globally. We also believe that if the learner reaches the core learning goals, he/she is most likely capable of applying the core knowledge to larger network environments in his/her daily work life.

Discussion

We will finally discuss lessons learnt and recommendations for future work. We will concentrate on the self-learning material generation as well as both virtual and physical laboratories. Discussion about the future of InCert certifications and corresponding training courses is also encouraged.

The approach to follow web standards and use open source tools turned out to be a success. The created self-learn material is globally usable and accessible with all modern operating systems and browsers. Although some minor delays occurred once a while in the learning period of web standards, the approach turned out to be very efficient from the content generator point of view. For the learning period the resources of W3Schools (W3Schools 2008) were considered especially useful. Due to free of charge nature of guides and tools available, the approach turned out to be highly efficient also from an economical point of view. Thus the approach is highly recommended to similar projects and tasks in the future.

The key lesson learnt from development of the physical laboratory exercises was that by simplification one can create relatively inexpensive set of exercises that can be easily distributed into global use. Although the simplification decreases the level of realism, we found that as long as the learning of core learning goals is supported, the simplification is justified compromise to enable the global use.

From an educational point of view, we recognize to simulation (both real and virtual) a big merit: to improve the awareness of actions carried out by a user so that he is conscious of his responsibilities and/or actions. From a practical point of view, the virtual labs outwardly solve the portability and staff issues while focusing the resource issue only on the software.

Especially for the Train2Cert Optical Networks course, having developed an open platform we can expect collaboration from other institutions and/or partners with the aims of both bug-fixing and widening the number of exercises. We could also set up a community where collect resources (e.g. skilled programmers), ideas or simply maintain a wish list.

We would also like to encourage both science and industry communities to join discussion on international certification and training courses. At the time of writing (September 2008) there are five months to the completion of the InCert and Train2Cert projects. After that the InCert Consortium is established to manage the certifications and training courses. The role of the consortium is to promote the certificates and training courses, watch over their quality, as well as manage the certification procedures. The InCert Consortium will consist of the current project partners and also organizations from outside the projects. Thus interested parties, both science and industry representatives, are encouraged to present views and ideas concerning the global certification and related training. Especially ideas and participation to the generation of new certificates and courses is encouraged.

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