Paper 6:

A hybrid network learning approach for technical education built around on-the-job training

V.C.Vescoukis and S. Retalis
Software Engineering Laboratory
National Technical University of Athens

{v.vescoukis, retal}@cs.ntua.gr

V.C.Vescoukis and S. Retalis

Summary

• Much has been said and written on the use of New Technologies in all levels of education and vocational training. There is no doubt that the emergence of technology will have a great impact on the look and feel of life in the future, including the way people acquire knowledge. All around the world, the educational systems strive to meet these new challenges. Many authors point out the fact that New Technology is used not only as a tool, but also as a target itself and raises important pedagogical issues. Although several experiments are already being conducted, much remains to be done in the design and evaluation of new learning environments in all fields and levels of education. We have been working in a real educational environment of secondary technical vocational education, exploiting the possibilities of strong learner participation in a learning context combining traditional classroom training, on-the-job training and Network-Based training. The main concept of our approach lies in the fact that practical on-the-job training is among the most valuable elements of secondary technical education. This activity can produce quite interesting results if effectively supported by a network learning environment (NLE). In our

approach, the content of the learning material within this environment is enriched by training material produced by the trainees themselves during their on-the-job training activities. The design, partial implementation and some lessons learned during this effort are presented in this paper.

Introduction

- Two types of schools, Technical Lyceum (TEL) and Technical School (TES), provide 3-year secondary-level technical training in Greece. The major difference is that schools of the TEL type work during day hours and have students aged between 15-19 with no professional experience, while those of TES type work during evening hours and have students aged 17 to 45 with some professional experience. Currently, on-the-job training is part of the curriculum of TEL and TES on an experimental basis. Discussions and further planning are still on the way. Still, most of the practical experience students acquire is provided through lab-based courses. These are conducted in a fully controlled laboratory environment which, of course, has little similarity to the real world. The official educational material used to support these courses as well as on-the-job training activities, is in the form of theoretical textbooks. In only a few cases, 'unofficially', trainers develop ad-hoc case studies, in order to do their job better, however this material is by no means certified or used effectively on a regular basis.

  It is obvious that this schema has several shortcomings:

  - Technical training at the secondary level needs to be very close to real world practices. Future practitioners (electricians, plumbers, etc) cannot be trained in isolation from the real practice environment. On-the-job training should become an institution and obtain the support it deserves.

  - Laboratory exercises should be designed in order to provide not only a better understanding of theory, but also a good approach to as many cases as possible met in everyday practice of the real job.

  - Training material should be case study oriented with references to the foundation theory whenever and to the extend necessary. Furthermore, a dynamic mechanism should be developed for keeping this material up-to-date by incorporating feedback from on-the-job practice.

The SCP Case–Situational Evaluation

- Sivitanidios Public School of Crafts and Professions ("SCP") is a public institution of secondary-level technical vocational education located in the area of Athens, Greece. One part of the vocational training offered in SCP is on-the-job training. 1500 secondary-level students aged between 16-20 (a few of them are aged up to 45) leave classroom-based training and work as trainees in real jobs. During this period, they have the opportunity to gain valuable experience in a real world environment where they practise what they have already learned in classroom. From the viewpoint of SCP, there is a problem in supporting this learning process, since students are not available for classroom discussions during that period of time. Moreover, there is lack of proper educational material for the students to handle problems that appear during their on-the-job training. The production of learning material as well as the establishment of a framework to support this kind of process using Networked Learning methods is considered to be not only a well-established need, but also a challenge.

  A 'boundary condition' in the aforementioned problem is the existence of a rather strict and well-defined program of studies designed for student populations with little diversity, as is the case in SCP. The background of this population comes from classroom and lab training of practical skills. Although some students may already possess some professional experience, the current practice has no mechanisms for exploiting and disseminating this experience to the rest of the students. It is our vision to develop mechanisms in order to turn the results of students' practical experience, both pre-existing and gained during on-the-job training, into useful learning material within a Networked Learning Environment that supports on-the-job training activities as well as the traditional classroom based teaching.

Scope of the networked learning approach

- In the SCP case, on-the-job training activities last two to four weeks and take place once or twice a year in groups of 100-200 participants. The first week after students have returned to classroom training could be used to examine the possibilities of creating new learning material from the experience gained. During this period, students should define the content and provide the material for the development of new learning modules. The development, classification and publication of the new modules to the web server that will host the Networked Learning Environment, will then be assigned to professionals under the supervision of domain and network-learning experts. Members of the teaching staff of SCP with little or no experience in the development of instructional material will be trained to become able to support this process, especially by evaluating the quality of the material provided by students based on well established quality criteria (one of them will be the students' profile which is already known).

  Incremental refinement, a well-established method in software development [7], will be used in the design and implementation of the proposed networked learning approach, as shown in Fig. 1. For each technical specialisation area of the students' on-the-job training activity a four-phase process takes place:

  - Preparation which includes structuring of the reports that will be filled upon completion of the on-the-job training activity
  - Assignment of students to companies and 2-4 weeks practice
  - Collection of candidate educational material based on the practical cases experienced by students
  - Development of the corresponding Networked Learning material

  The last two phases are supported by experts in the design and presentation of learning material, as well as by professionals who actually do the admin-

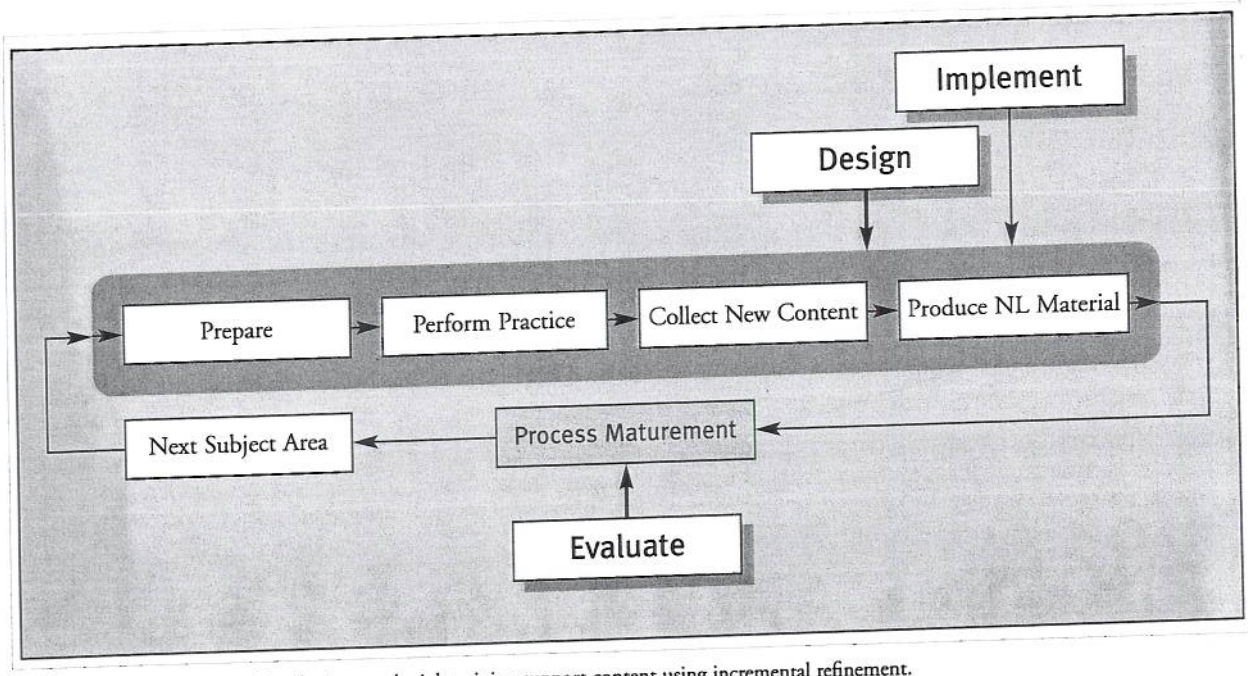

Fig. 1. The process of developing on-the-job training support content using incremental refinement.

istration of the Networked Learning Environment. After this 4-phase process is complete, an evaluation of the process itself by instructional developers (ID) takes place, and a more refined version (more pedagogically effective) of the learning material is being produced to be used for supporting the learning process of the SPC students. If necessary, content of learning material produced during earlier iterations will be updated.

What makes this approach interesting, is that learning material is produced by students for students, and thus reflects the way students themselves , not some remote authority, conceive their needs and practical experience. Furthermore, this content will be added in a Networked Learning environment [5] in which on-the-job experience is accumulated, classified, can be accessed not only by students, but also by active professionals and can support the learning process.

The educational philosophy of the SCP learning approach lies in two pedagogical methods: learner-centred method and case-based learning. The focus of the learner-centred method is on the active participation of the learners and on the variety of different means of knowledge transfer and acquisition. Undoubtedly, teachers have the major responsibility for what and how the students learn. However, the students should not be just puppets, dancing to the tunes of their various teachers [1] but the educational settings should provide them with access to information and learning WHEN, WHERE, HOW the learner wants [4].

Case-based learning differs from traditional lecture-based learning in the sense that knowledge is not represented as theory but in examples. Case-based learning builds on the idea that human expertise is not comprised of formal structures (like rules), but of experience [5]. In addition, the learner can find the solution to a new problem by retrieving similar problems from a case library and adapting those solutions to the new problem definition.

A hybrid learning environment

Content

There are three factors that have been of most influence in our conceiving the idea of a hybrid learning environment: human agents involved, existing learning material and process characteristics. The human agents are both trainers and trainees. Trainers have to cope with the difficult task of delivering not only new theoretical knowledge, but also practical skills and well-specified case studies. Trainees need the confidence that they get

in the skills they need to find a job - besides, this is the reason they decided to get vocational training in the first place. They also need to actively participate especially in the practical part of training. There are several cases where they know better what is useful to learn and what is not.

The second factor, the existing learning material, is targeted to theory and is not so helpful in practice. A key point here is that learning material appropriate for practice is actually produced during practice. Students should be those who can identify and provide most of its content according to the networked learning approach illustrated in the previous section. Finally, the whole learning process which takes place in a distributed environment: partly in traditional classes, partly in labs and partly in real job locations. A network learning environment (NLE) cannot replace tuition in either of these locations, but it can be of great assistance and support, provided that the proper content will be offered. This is why the adjective "hybrid" has been considered proper for our approach.

Based on what has been mentioned above, the main elements of our concept for a networked hybrid learning environment are the following:

- Four ways of learning should co-exist: traditional classroom-based teaching, practice in laboratories, on-the-job training, plus Networked Learning methods, each one having a complementary role to the others.
- During on-the-job training, students themselves identify and provide most of the content of new learning modules to be added to the content of the learning material within the environment, which in this way is constantly updated.
- The NLE should be accessible to trainers and students in the preparation and support of on-the-job practice activities, as well as to practitioners who need access to reference material or to a library of practical cases.

Architecture and implementation

A general architectural overview of our hybrid learning environment is shown in Fig. 2. Traditional classroom teaching provides students with the basic theoretical knowledge required to attend laboratory practice. The latter prepares students for on-the-job practice activities that take place either in local companies or in an experimental enterprise run by SCP, the SCP Technical Assistance Centre (SCP-TA). This is shown by dashed arrows in Fig. 2. Traditional bibliographic material supports all three activities mainly for reference purposes. A Network Learning Environment (NLE) provides not only electronic reference material, but also case studies, communication services, etc to trainers and students [3].

The innovation of this architectural schema lies in the students' ability to trigger the production of new learning material that will be added to the NLE. This material consists of case studies and experience reports from real cases that students have experienced while doing their on-the-job practice. Furthermore, the NLE will be accessible not only by current SCP students, but also by active technical practitioners of every age. Thus, such practitioners have the opportunity to update their technical knowledge not just by using some "remote electronic book", but by viewing experience reports on current real world problems together with suggested solutions, related issues, references, etc, authored by other practitioners who actually 'speak the same language'.

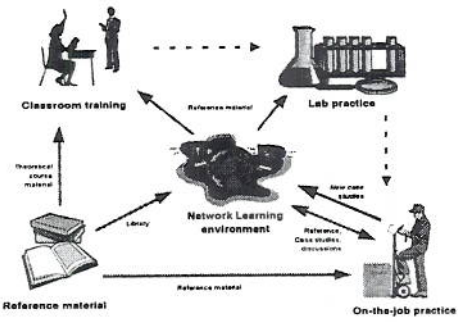

Fig. 2. An architectural overview of our hybrid system.

As for the NLE, at a physical level it is a distributed system and uses the client-server model. There is a server, in which all material is centrally stored, and many clients, one for each user accessing this

material. The clients need not be physically located in the SCP, but they can connect to it through the SCP network, through the Internet or via a regular phone line. The main characteristics of the NLE are:

- The environment provides the students with a means of submitting questions and the instructor with a means of answering them. It implements a communications channel, in which all students and the instructor participate and discuss matters related to a specific course electronically. The content of the discussions that take place, as well as all questions and answers, can be stored in such a way that they can be reused.

- The educational material in the NLE is widely available and can be accessed by many computers from many different locations at the same time. It is also hierarchically structured and uses hypertext links in such a way as to facilitate and guide the users.

- The environment facilitates the users in their attempts to locate and access course related material that is distributed in the Internet.

Its basic design accords with the specification requirements of a NLE used at the National Technical University of Athens, Greece [3].

Operation

- How does the hybrid learning environment work in the real world? The flow of student activities is shown in Fig. 3. During the first year students attend mostly classroom lectures supported by the NLE. Balance during the second year turns to lab exercises where they get the basic practical skills to tackle technical problems in a laboratory simulation of the real world. During the third year students become part-time 'staff' of the "SCP Centre of Technical Home Assistance" (SCP-TA). SCP-TA is a student venture providing services (home electricians, plumbers, etc) to households located around SCP, the first of its kind in Greece.

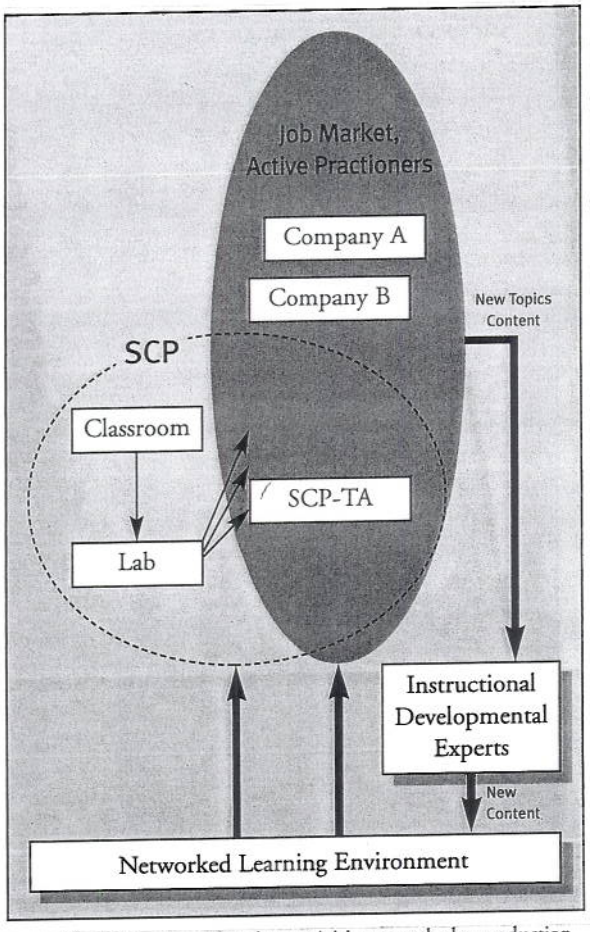

Fig. 3. The flow of student activities towards the production of new content from their own experience.

Apart from continuing to attend both classroom and lab, as staff of SCP-TA, students are on-hold for clients' calls whose requests they satisfy under the supervision of experienced practitioners. During this process both students and supervising practitioners have access to the NLE for reference or study of similar cases. For a 2- to 4-week period, students have the option of either becoming full-time staff of SCP-TA or having their on-the-job practice at local companies. Upon return to the classroom, students can suggest new case studies to be added to the NLE, for which they provide the core content as they have conceived it during their own practice. This learning material is then passed to ID experts who make the necessary modifications, classification and production of the instructional material that will be added to the NLE.

Lessons learned

The architectural schema of the proposed hybrid learning environment has worked for more than one year in SCP with the participation of more than 800 students from three technical specialties: home electricians, industry electricians and home plumbers. During the same period, the NLE has been under development offering services of reference material provision and group collaboration. We have learnt several useful lessons worth mentioning in the sequence.

Lesson 1. In the beginning, students did not understand the added value of the Network Learning environment. They thought that everything they needed to know was 'in the box'. It took students at least 2 to 3 months to realise the complementary role NLE plays in this schema. After this was accomplished the ice broke and a remarkable increase of student interest took place. However, after another couple of months students began to consider the NLE as a source for on-line reference material. Up to that point no case studies had been created and added to the NLE.

Lesson 2. It is after the first on-the-job training activities have taken place, that the student conception of the NLE changed. Students came back with lots of suggestions of case studies they considered worth adding to the NLE. There are two points worth noting here: first, the NLE is not anymore considered by students as some 'electronic authority', as is the case of a traditional textbook. It has become a live tool, in the content of which their suggestions are of vital importance. Second, although students may have lots of suggestions for new topics, they appear to be weak in classifying and describing their experience in the form of new learning material.

This weakness can be traced back either to the structure and documentation of the forms designed to be used by students in writing down the new content, or to the students' ability to produce plain text. Nevertheless, this fact has been an important piece of feedback taken into consideration in the design of the next version of the process to be followed in collecting students suggestions, as shown in Fig. 1. In the first two runs of the 4-step process shown in Fig. 1, the instructional development experts have done more work than initially expected.

Lesson 3. After collecting students experience reports and suggestions, classifying and developing new content, the NLE was enriched not only in quantitative, but also in qualitative terms. Content whose development was triggered by students' practical experience is a new qualitative attribute of a NLE. Next generations of students have access to useful pieces of accumulated experience, which have been created by a compatible mentality - that of their colleagues.

Lesson 4. Practitioners who have access to the NLE consider the case-study-oriented content more useful than the other services of the NLE. A study of the browsing habits of about 100 SCP graduates who had access to the NLE, showed that they spend more than 60% of their time in the NLE browsing through the case studies. It is expected that when this content is available through the Internet, the same behaviour will be observed among the frequent visitors of the NLE publicly available pages.

Lesson 5. Tutors who supervise students' on-the-job training and discuss with them their experience in preparing their suggestions for new NLE content, feel that the distance between student and tutor becomes smaller when learners play such an active part in the learning process. During these very active discussions tutors approach learners and discover things they could never imagine students could do or think. Some tutors have pointed out that students break the barrier of passive reception of knowledge and become active participants in the learning process.

Concluding remarks

- This paper presents an approach to enhance the learning process of students of secondary-level technical training. A hybrid learning environment has been developed for this purpose incorporating traditional classroom-based teaching methods, laboratory practice, on-the-job training and the use of networked learning methods. This merger of methods in one educational schema seems to be

effective. Concerning the use of networked technology, it is found that when network learning is viewed as a tool that plays a complementary role in the learning process, most of its shortcomings disappear, while practically all of its benefits are still evident. Concerning the learner-centred approach of the hybrid learning environment, students prefer to be the constructor of learning material based on their practical experiences. Of course, much has still to be done in order for students to produce better quality instructional content. The results obtained so far from the experiment we conducted in SCP are quite encouraging and we are currently in the process of designing a wider deployment.

Acknowledgements: This work is supported by the Second Community Framework Program for Education in Greece (EPEAEK). The authors would like to commend the administration of SCP and Mrs. P. Niniou for their valuable assistance.

Bibliography

1. Graziadei, W. (1997) Implications for Teaching and Learning: A paperless classroom but NOT a teacherless classroom, http://137.142.42.95/TL/Change.html

2. Hiltz, R. (1995) The Virtual Classroom Learning Without Limits via Computer Networks, Ablex Publishing Corporation, U.S.A..

3. Koutoumanos, A., Papaspyrou, N., Retalis, S., Maurer, H. & Skordalakis, E. (1996) Towards a Novel Networked Learning Environment, Proc. of World Conference of Web Society (WebNet'96), San Francisco, USA.

4. Laurillard, D., (1993) Rethinking University Teaching: a framework for the effective use of educational technology, Routledge, London.

5. Nagendra Prasad, M. V., Lesser, V. R., Lander, S. (1995) Reasoning and Retrieval in Distributed Case Bases, Journal of Visual Communication and Image Representation, Special Issue on Digital Libraries, Vol 7, No. 1, March 1996, pp 74 - 87.

6. Retalis, S., Haugen, H., Ask, B., McConnell, D., Skordalakis E. (1998) What educational challenges are we now able to meet, given that new technologies are available to students and the average citizen? Bringing Infromation Technology to Education, March 25-27, 1998 Maastricht, The Netherlands.

7. Somerville, I. (1995) Software Engineering, Addison Wesley.