Chapter XI
An Integrated Architecture for Supporting Vocational Training

C. Bouras
University of Patras, Greece

E. Giannaka
University of Patras, Greece

Th. Tsiatsos
Aristotle University of Thessaloniki, Greece

ABSTRACT

E-learning and Web-based training have evolved over time from a newborn trend for complementing the learning process to a major form of education and training for supporting mainly geographically scattered users. The basic aim of this chapter is the description of a platform for open and distance training, which is mainly focused at supporting the needs of Vocational Training Centers as well as of institutions providing life-long adult training and learning. In particular, the issues that this chapter focuses on are vocational education and training characteristics and requirements, the current situation and technological trends in ICT-supported VET, the development framework and processes while it also proposes basic vocational training services and the system architecture of the integrated platform. The presented platform aims to provide services of both synchronous and asynchronous and collaborative distance learning.

INTRODUCTION

Information and communication technologies (ICT) have been considered, from the early begging, a facilitator to education and knowledge. The evolution of these technologies in combination to the emerging of new technologies over time as well as the high degree of familiarization of indi-

viduals with their use offer advanced possibilities for learning and training. To this direction much research and work has been realized for defining the basic components an e-learning/training system should have as well as for extracting the basic needs of the users that these systems target. However, learning and training, can be applied to a wide variety of fields and areas, each of which is accompanied by some special characteristics related to the field of learning/training, the tools needed for the realization of the training process as well as the familiarization of the target audience to the selected technologies. Most of the technologies used for providing and supporting distance learning and training need to address a variety of challenges which are related, among others, to the provision of education to an increasing number of users as well as the training with, and in fast, changing technologies, and improvement of the instructional systems (Herremans, 1995).

One of the cases where Web-based training can be effectively adopted is the vocational education and training (VET). At the beginning, the main goal of vocational education and training was to prepare trainees (workers or students) for entry-level jobs in occupations requiring less than a baccalaureate degree. However, as stated by Levesque et al. (2000), "The last decade, this purpose has shifted toward broader preparation that develops the academic, vocational, and technical skills of students in vocational education programs." The introduction and incorporation of ICT in vocation training for the development of new and advanced ways of training and learning emerges as a necessity in the rapidly changing technological society. Furthermore, advanced technologies for training (simulations, communication, collaboration and assessment tools) can increase the array of learning opportunities both for the trainees and the trainers (OVAE, 2006).

Currently, there is a great number of tools and systems developed for providing and supporting Web-based training processes. In their vast majority, these systems choose either a synchronous, asynchronous or collaborative mode for achieving their goal with little or no integration and combination of these modes. The basic aim of this chapter is the description of a platform for open and distance training, which is mainly focused at supporting the needs of vocational training centers as well as of institutions providing life-long adult training and learning. The presented platform aims to provide services of synchronous, asynchronous and collaborative distance learning into one integrated system.

The chapter is structured as follows: Section 2 presents the background on vocational education and training, in terms of the current situation on ICT-supported VET as well as on the current trends in online VET technologies. Section 3 describes the basic vocational training features characteristics and requirements so as to define the differences and modification in regard to other types of education and for extracting the needs and motivation of the target users. The section that follows presents the framework for the support of vocational training which is built upon the basic needs of the targeted users. Section 5 describes a set of proposed services that such a system should provide and support, based on the requirements, features and characteristics of a VET system, described in the previous section. Section 6 is engaged to the description of the system architecture, in terms of the logical view of the static structure of the architecture, the dynamic behavior of the system in terms of the specification of the system behavior, collaboration of components for achieving the system behavior and the physical view of the Web-based training system related to the deployment of the system. Section 7 summarizes and concludes the chapter, while section 8 presents the planned next steps.

BACKGROUND

There are many definitions for vocational education and training (VET). According to Wikipedia

(2006) VET, also called career and technical education (CTE), prepares learners for careers that are traditionally non-academic and directly related to a specific trade, occupation or vocation, hence the term, in which the learner participates. It is sometimes referred to as technical education, as the learner directly develops expertise in a particular techniques or technology.

Usually, VET is a term used to describe education and training arrangements designed to prepare people for work or to improve the knowledge and skills of people already working somewhere. It also describes one of the three major sectors of education and training, the other two being the school and higher education sectors. However, due to reforms in various countries, during the past decade we now see vocational education and training programs offered in secondary schools.

As the labor market becomes more specialized and economies are demanding more skills, governments and businesses are increasingly investing in the future of vocational education through publicly funded training organizations and subsidized apprenticeship or traineeship initiatives for businesses. At the post-secondary level vocational education is typically provided by an institute of technology, or by a local community college. It is indicative that over 94% of Australia's secondary schools now offer VET to their senior students. This means students can gain practical work skills and nationally recognized VET qualifications as part of their school education. This fact is very beneficial for the industry because the students already have some experience and possibly qualifications in the industry. Through their work experience placement they should have developed a realistic picture of the industry and be aware of such things as the expected level of grooming and required attitude to be successful.

According to the above we can definitely say that VET is very beneficial for a big portion of workers and/or students.

However, there are many people who can not participate in such a VET traditional program in a school or institute, due to time and/or distance limitations.

In such a case the usage of e-learning and ICT in VET process either exclusively (which means that the whole VET process will take place from distance using ICT) or partially (which means that ICT technology will support but not substitutes the traditional VET process) could be very useful. The next paragraphs investigates the current situation on ICT-supported VET as well as on the current trends in online VET technologies.

Current Situation on ICT-Supported VET

This paragraph presents an overview on the work done until now in the usage of e-learning and ICT in vocational training in order to support asynchronous, synchronous and collaborative learning services. The main goal of presenting the related work overview is to reply to the following question: Can e-learning technologies help the vocational education and training students and teachers?

Generally speaking, the usage of ICT for supporting vocational training is one of the highest priorities not only in Europe but also in other countries such as the U.S. and Australia. According to a study of Australian Flexible Learning Framework (2005), which presents the results of national surveys and demonstrate the level of uptake and use of e-learning in Australia's vocational education and training (VET) system, there is a modest but increasing level of uptake of e-learning. Furthermore, the surveys shown that e-learning would help the students by increasing their confidence and computer skill levels, by helping them to get a better job and by giving them flexibility in the place and time of their study.

In case of European countries, improving vocational education and training and a stronger

cooperation throughout Europe in VET is increasingly being regarded as an important element for creating a European labor market, implementing the European employment strategy and meeting the Lisboan goals set for Europe's competitiveness, social cohesion and job creation. The final report to the EU Commission concerning the use of ICT for learning and teaching in initial vocational education and training (Ramboll Management, 2005), shows several clear patterns concerning the reasons for using e-learning in initial VET (motivations and objectives) and the expected results, outputs and impacts. These generally revolve around the following themes: the flexibility of e-learning, new learning methods, opportunities for furnishing students with real-life work skills, savings in time and money, the integration of theory and practice and attracting students. This study shows that the subjects/branches considered to be characterized by an intensive use of e-learning are: electricity, gas and water supply; financial intermediation and business activities; wholesale and retail trade, hotels, restaurants; manufacturing; transport; storage and communication. Furthermore, the study shows that the subjects/branches considered to be characterized by a moderate use of e-learning are: agriculture, fishing and quarrying; construction; public and personal services.

Concerning the extent to which e-learning is used in initial VET, the findings show that the EU as a whole is at an early stage of the process of integrating e-learning into its initial VET systems. In addition, the overall picture that emerges from the study shows that the use of e-learning in initial VET varies greatly among the Member States, as some are still at the beginning of their development in this area while others have been working to implement e-learning in initial VET for several years.

Concerning the impacts of the use of e-learning in initial VET in EU member states, the report of Ramboll Management (2005) refers that e-learning may: bring the practical and the theoretical worlds closer together, enhance the level of knowledge, skills and competences of students and prepare students for working life. E-learning may also: increase flexibility, efficiency and quality of teaching, student motivation and parental involvement. Furthermore, the use of e-learning may: change the role of the teachers, make the students responsible for their own learning, prepare the students for the lifelong learning paradigm and generally lead to individualized learning.

According to the above it seems that we can answer our initial question and we can say that e-learning technologies can help the vocational education and training students and teachers.

Current Trends in Online VET Technologies

Distance learning and training has drawn increased research interest and a wide variety of architectures for supporting this type of learning and training have been proposed. In addition, to this direction many tools have been developed for supporting and assisting the realization of the Web-based training process and for increasing its benefits for the end users, which is the achievement of a higher degree of knowledge. Based on the above, the chapter will survey existing tools and platforms designed and developed. The technologies that could be used for vocational training could be divided into three major categories: (1) synchronous, (2) asynchronous and (3) collaborative. In the subsections that follow, an overview of the existing technologies in the above three categories is presented.

Technologies for Synchronous Communication

The technologies used for synchronous communication refer to the real time communication among the participating peers. To this direction there are mainly text messaging and voice chat technologies. In particular, the majority of the

synchronous communication technologies include tools for conducting real time voice chatting, embed voice, set up threaded voice board and oral assessments into course materials. In addition, the majority of the existing platforms are accompanied by additional tools for facilitating the interaction among the users, such as file transfer, video communication and even mobile messaging. Some of the technologies of this category are Skype, MSN Messenger and ICQ, while similar tools can be built upon technologies that allow real time communication, such as Macromedia Communication Server.

Technologies for Asynchronous Learning and Training

Another category of systems that could allow collaboration are the systems that aim at providing a global platform for a whole educational program, such as WebCT, Learning Space, CENTRA, FirstClass, Claroline, CourseWork, Moodle, Eledge and Whiteboarb, CommunityZero. Most of the platforms mentioned above, provide tools which most of the early Web-mediated online courses were designed to complement conventional methodologies for dissemination of course content, connecting students to various online multimedia learning materials. Concerning the learners themselves, traditional platforms for distance education, dispose tools and functions that facilitate the exchange of information or materials (that is communication), without offering specific tools that could really allow collaboration among them.

Technologies for Collaboration

The technologies used for collaboration are mainly related to real time applications, which allow an advanced degree of interaction among the participating peers. Collaborative technologies could be considered as a superset of synchronous communication tools, which apart from the communication feature extend the users' abilities by supporting advanced features which allow to a group of users to work together on a certain task. The most common characteristic of collaborative technologies is the real time sharing of applications among the participants along with a number of advanced features (whiteboard, co-Web browsing, brainstorming board, etc.), which facilitate the collaborative process. Some of the platforms available to this direction are the following: Centra Live, AcuConference, ScribeStudio, Netmeeting, Live Meeting, Live Classroom & Wimba Voice Tools.

Synopsis on Existing Technologies

The number of architectural models, platforms and tools developed for distance learning and training raises the question whether it is necessary to design and develop a new architecture so as to meet the needs of Web-based training. The review of the current trends in online VET technologies indicate that even though there is a majority of platforms and tools available that could be adopted for conducting and facilitating certain types of Web-based training processes, there is no integrated solution and architecture that combines all the necessary services into one platform. In particular, the majority of the existing platforms focus either on mainly synchronous collaborative tools or asynchronous learning tools for achieving the goals of the e-learning and training process. However, given the fact that both e-learning and Web-based training can be applied to a wide range of educational fields, it seems that a solution that could provide and support a set of synchronous, asynchronous and collaborative technologies would be more effective for the Web-based training process, as it could assist and facilitate both trainers and trainees as combinations of different types of tools could be adopted according to the topic of interest.

VOCATIONAL TRAINING CHARACTERISTICS AND REQUIREMENTS

The starting point when designing and developing an e-learning or Web-based training system is the identification of the special characteristics of the users it targets and the objectives it aims to achieve. In the case of vocational training the users of an e-learning vocational system are trainees (who are adults with some knowledge on the theme area that they will be trained on and they wish to enrich their knowledge), administrative staff and trainers. This section presents the special characteristics and particularities of life-long vocational training so as to define the differences and modification in regard to other types of education and for extracting the needs and motivation of the target users. Based on the needs and characteristics, this section outlines the different requirements that arise for vocational training and presents the pedagogical models that could be applied for assisting this type of training.

VET Features

According to the current situation concerning VET programs offered today world-wide, we can present the following general features of VET:

- VET covers education and training useful both before and during employment. It assumes that people will undertake VET throughout their working lives.
- VET includes both craft-based training (associated with traditional apprenticeships such as cabinet making and boiler making) and industry-wide training (for example, broad-based metals modules and office skills modules). It also includes general employment skills such as communication and occupational health and safety.
- VET is provided in institutes and in the workplace. Workplace training can be on-the-job, as with apprenticeships, or in the industry-based training programs and facilities (known as skills centers) found in some larger companies.
- VET programs could range from basic level and skill-specific courses to more advanced and broader courses awarding qualifications such as advanced diplomas.
- The VET programs should be accredited by the body responsible for accrediting training.

In general, the online VET technological systems do not seem to be characterized by a solid pedagogical framework in order to satisfy both learners' and VET organizations' requirements. This framework should be applied by using pedagogical methods suited to adults rather than to the young. This implies learning that is learner centered and contextualized to make it relevant to adults' experiences.

A social–constructivist learning approach through problem solving in both individual and collaborative framework seems to be an optimal solution. More specifically a socio-constructivist learning environment could be characterized by the following functionality (EduTechWiki, 2007): reflection and exchange, scaffolding and storyboarding, facilitation and content, monitoring and assessment, production, investigation psychological support and community.

Such an environment should be characterized by flexibility in provision to suit adults' circumstances and schedules. Furthermore, it should recognize the prior learning of the trainees (OECD, 2003). This could be done by assessing and giving credit for knowledge and skills acquired in work, home or community settings ensuring that adults do not waste time relearning what they already know.

In addition, Manninen et al. (2000) has presented criteria for pedagogical and technological innovations in vocational training environments.

The criteria for pedagogical innovations in vocational training environments are the following:

- **Constructiveness**: Teaching and learning are clearly based on the learner's active construction process and on the higher-level knowledge structures. In an ordinary VET environment teaching does not pay much attention to how the subject matter is integrated in the existing knowledge structures of the student.
- **Activeness**: Learning environment is based on the learner's active role and commitment. In an ordinary VET environment the learning environment does not support nor require the learner's own active role in the learning process.
- **Cooperativeness**: Learning is based on cooperative and collaborative principles and takes place in groups. In an ordinary VET environment learning takes place mainly alone.
- **Contextuality**: Learning takes place in a simulated or real-life situation, which equals the actual context where the knowledge will be applied. In an ordinary VET environment learning takes place in an institution and/or is separated from the concrete situation of application of the knowledge.
- **Problem-based**: Learning approach is problem-based and investigative. In an ordinary VET environment study objectives are based on study subjects in a traditional way, and cut into separate units in the curriculum.

The criteria for technological innovations in vocational training environments are the following:

- **Interactivity**: Tools are based on interactive technology (interactive video, interactive WWW-pages, learning programs). In an ordinary VET environment tools developed in the project are mainly based on passive receiving information (video, tv, WWW-pages).
- **Communicativeness**: Tools allow many-to-many-type communication. In an ordinary VET environment tools allow many-to-many-type communication.
- **Individuality**: The tools make it possible to create and follow individual study paths. In an ordinary VET environment, the learning process using the tools will be similar for all the users
- **Multimedia**: The product is an innovative combination of alternative tools supporting each other. In an ordinary VET environment, the product is based on a single tool.

According to the above we can extract the basic requirements and characteristics of an online VET system, which are described in the next paragraph.

Basic Requirements and Characteristics of an Online VET System

This section presents the basic requirements that should be taken into account by designers and developers when they are designing a virtual space for vocational training systems.

For extracting the basic design characteristics, we should first define the target groups that it involves. Thus, in the case of vocational training centers we should extract the design characteristics for the following entities (stakeholders):

- Vocational center administrative staff
- Trainers
- Trainees

From the perspective of the vocational center **administrative staff**, an online VET system should:

- Allow the vocational center to serve a greater number of trainers and trainees: the online substance of the Web-based training system overcomes the spatial limitation that a real class introduces and should therefore provide all the necessary means, in terms of resources, for the support of multiple trainers and trainees. In particular, the system should allow the assignment of more trainers for the conduction of a training course, as well as the ability to serve more trainees at the same course.
- Allow the vocational center to serve a greater number of training courses: the system should provide and support all the available online tools for the realization of different types of courses, which, based on the field of expertise, could demand different types of tools and services.
- Improve the administration and management of trainees' and trainers' performance: the online system should provide all the necessary tools for monitoring the trainees' profiles and performance as well as the effectiveness of the trainers' in the conduction of the Web-based training course. This information is of vital importance to the organization as it could create and maintain a unified view of the effectiveness and progress of the participating peers.

As far as it concerns the **trainers'** perspective, the system should:

- Facilitate content creation and manipulation and improve content availability: the content constitutes a critical factor for the learning and training success. Therefore, the system should provide all the necessary tools for the easy creation and manipulation of the content by the trainers, so that they will not be discouraged by spending time and efforts on how to complete these processes.
- Assist and improve the sharing and distribution of content within the course, among trainers and trainees: following the content creation is the content presentation and distribution. The system should assist the effective sharing of content within the course and among the participating trainees, as well as among the trainers of the system for increasing the reusability and training consistency.
- Improve communication both in and out of the training class with trainees and other trainers: the online VET system should effectively simulate the communication capabilities among trainers and trainees as well as among trainers themselves, in real-world vocational training situations. Therefore, the system should provide all the necessary communication tools and services for overcoming the boundaries that both time and spatial distribution of the participating entities introduce.
- Improve and facilitate assessment capabilities: the online VET system should provide to the trainers all the necessary tools for evaluating trainees' performance and understanding of the training material. The assessment options should not only efficiently "simulate" the real life assessment processes but additionally they should overcome the limitation of no physical presence of the participants and the lack of face-to-face contact.

Finally, from the **trainee's** perspective, a vocational training system should:

- **Improve overall training and facilitate the training process by decreasing the learning curve on IT technologies:** The online system should act not only as a facilitator to

the training process but also as a coherent system that can meet the training needs of the trainees. In addition, the interface and the selection of the technologies should match the technological skills of the trainees for avoiding their discouragement by complex technological features, which in turn act as boundaries for gaining knowledge.

- **Provide effective Web-based training support:** Based on the fact that the online system refers mainly to scattered users, it should be able to provide all the necessary tools for the timely and efficient support on the Web-based training processes, which will facilitate trainees in completing these processes. The online system should also extend the support capabilities to the trainees by exploiting the advanced capabilities of existing technology.
- **Promote the personalized nature of the Web-based training process:** the online system should provide all the necessary tools for the creation of trainees' profiles, the extraction of the special needs that each of them introduces, their skills and possibly the areas that they need additional assistance and support. Based on this information, the trainee could have the opportunity to enter a training system with information, content and services that best match his/her interests and skills, which in turn could improve the effectiveness of the Web-based training process.

Another very significant issue is the content creation and its presentation to the users. An online VET system, which is a Web-based system, should definitely follow W3C's Web Content Accessibility Guidelines (W3C, 1999) concerning the representation of the content. Furthermore, the content should be relevant to the users' needs, learning topics and be able to be presented in various forms such as video, animation and/or text. Finally, the content should be created in such a manner in order to support reusability of learning objects.

DEVELOPMENT FRAMEWORK AND PROCESSES

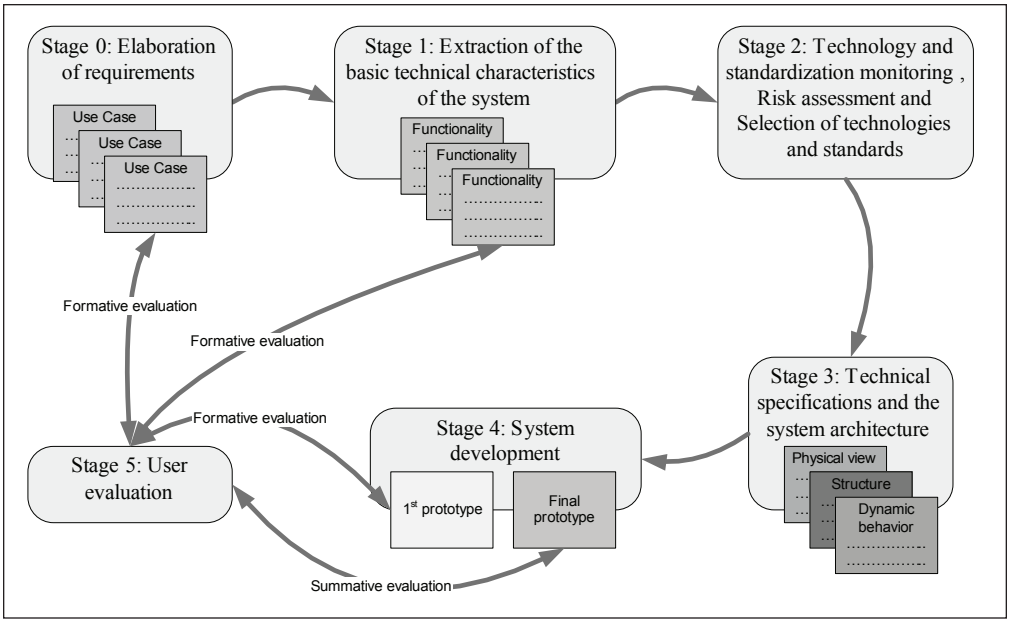
For an effective and flexible system for supporting vocational training, the investigation of a development framework is identified as a basic issue. This development framework will be used, among others, as a basis for the selection and/or the implementation of information and communication technologies in order to create an efficient VET technological system. In other words this framework could be considered as the skeletal support, which is used as the basis for the functional and technical development of the training system. The chapter presents a development framework for the support of vocational training which is built upon the basic needs of the targeted users.

The framework consists of the following stages:

- **Stage 0:** Elaboration of requirements.
- **Stage 1:** Extraction of the basic technical characteristics of the system.
- **Stage 2:** Technology and standardization monitoring, Risk assessment and Selection of technologies and standards.
- **Stage 3:** Technical specifications and the system architecture.
- **Stage 4:** System development.
- **Stage 5:** User evaluation.

The correlation among these stages is depicted in Figure 1. It should be noted that the proposed framework includes four evaluation steps (three steps dedicated on formative evaluation and another step dedicated on summative evaluation). VET special characteristics necessitate all these steps. Some of these characteristics are the following:

Figure 1. Development framework and processes



- Extremely different subject-matters.
- Various status of trainee's group (e.g., different age, different cognitive background, unemployed or not, etc.).
- Various dexterities on ICT technologies.
- Diverse learning curve on IT technologies of trainees' group as well as trainers' group.

These characteristics enforce the users' intervention in the system development process from an early step (i.e., use cases description) to the end of the development process (i.e., summative evaluation of the final prototype) design and evaluation.

Therefore, we can say that the proposed development framework can be characterized as a user-centered system development process. This fact will facilitate the users to use the system as a tool for their work or learning process. Furthermore, it will decrease the learning curve on the VET online system by avoiding problems reported in other system development processes (Seale, 2003). The next paragraphs are dedicated on the description of the stages of the development framework.

Stage 0: Elaboration of Requirements

The proposed framework has the following basic inputs: (1) the VET characteristics (i.e., VET national system, VET regulation framework, VET special characteristics comparing with the other forms of education and training, etc.); (2) the end user requirements (i.e., the teachers, students and administrative stuff requirements, etc.); (3) the guidelines that stem from the application of pedagogical models in a distance learning environment; and (4) use case description. In essence, this stage is a pre-step during the system development process. More specifically it constitutes the collection of the whole set of requirements for the design and development of the system. The most significant step for the design of the system is the use case description. Use cases describes the context of the system and the problem(s) that

it solves. The aim is to provide an introduction to the system that is accessible to non-domain experts. The problem description enumerates the key features of the system and how the system provides value to them. The focus of this step is on the features concerned with and communicating with the system, and on the roles of these features, not on the system itself. The results of this stage could be reported to the end users of the system in order to receive early feedback.

Stage 1: Extraction of the Basic Technical and Functional Characteristics of the System

This stage concerns a primary effort to extract some of the most basic technical characteristics of the system, based on the inputs and requirements collected on "Stage 0."

The main goal of this stage is to describe the system interface and system functionality (Section 3) as well as to document the services that the system provides in terms of responsibilities. Often the system interface may be organized into a set of sub-interfaces, each sub-interface corresponding to a distinct usage of the system, for example, there may be specific interfaces for system configuration, for normal system use, and for system management. This stage is mainly focused on the normal system use. Each system interface proposed to be presented as a wireframe. Along with the system interfaces the specific system functionality are described using the template presented in Table 1.

According to these characteristics the technological fields connected with the targeted system are detected.

This stage is mainly related to the list of services that need to be identified within the framework, which are based on the requirements, and for each of these, the definition of the scope and purpose of the service, a list of applicable standards and specifications are among others presented.

This step will help the project manager and the technical manager to anticipate the technical expertise needed for the successful development of the system.

Furthermore, the results of this stage could be reported to the end users of the system in order to receive early feedback.

Stage 2: Technology and Standardization Monitoring, Risk Assessment and Selection of Technologies and Standards

This stage concerns an extended monitoring of the technologies, platforms and/or standards available in each research field and from these explored there was a selection of the ones that met some basic criteria.

Table 1: Functionality template

Functionality Name	Name of the functionality
Relative Use Case(s)	Use Case(s) where the functionality could contribute
Relative Element	Feature that this functionality corresponds to (e.g. Forum)
Actors	Users or system components that will use this functionality
Input Data	Data needed for the implementation
Description	Process that will be followed for the achievement of the functionality
Output Data	Expected result

The main criteria for the selection of one technology in regard to another are the following:

- If and how this technology could contribute in the framework of a VET technological system.
- Compliance to the relative standards that Underlay in this research area.
- the functionalities that it provides.
- Its cost.
- The familiarization of the developers with this technology, and finally.
- The interoperability with operating systems and other technologies.

After that, an intermediate step concerns the risk assessment for each technologies, platforms and/or standards. More specifically, for each product an independent potential risks analysis should be carried out in the following categories: (1) Design/Planning; (2) Development; (3) Integration; (4) Implementation/Exploitation; (5) Ongoing Support; (6) Future Development.

Stage 3: Technical Specifications and System Architecture

The purpose of this stage is to define the technological basis for the system as well as to identify the relevant tools and protocols to be implemented. Furthermore, this document tries to define the system architecture in the form of functional blocks and their interrelations, including a description of hardware and software requirements on the server and client sides, providing as much detail as possible.

This stage has, as goals to describe the structure, the dynamic behavior and the physical view of the VET system

Stage 4: System Development

After describing the system architecture, the system development should start by implementing the system functionality. It should be noted that some parts of the system functionality should be released gradually to the end-users.

One of the main requirements that needs to be considered when launching such a system is that the introduction of additional technological features should proceed gradually and the added value of each feature must be clear to the user. This is why not all functionalities of the system will be launched at once so as not to overload users with too many unfamiliar features.

We propose two steps for launching the functionality:

- An intermediate prototype, including basic features and ready for formative evaluation.
- The final prototype, including the whole set of functionality and ready for summative evaluation.

Stage 5: User Evaluation

The main reasons for conducting evaluations are to discover the potential problems in advance as well as to contribute to our understanding of the application of new technologies to training and to be able to make generalizations from our work.

Two levels of evaluation were identified, the need for formative evaluation to identify problems at an early stage, and the need for summative evaluation to provide evidence to potential users:

- Formative evaluation is evaluation that includes a feedback loop leading to remedial actions. The results of the evaluation are used to modify the development process or output. Formative evaluation could be applied in three steps: (1) after the presentation of the use cases, (2) after the presentation of system functionality description, and (3) after the presentation of the intermediate prototype.

- Summative evaluation is evaluation that proposed to be carried out at the end of a project. Its purpose is not to improve the project outputs but to provide information, for example, to assist in decision making, to support claims, to assess achievement against goals.

PROPOSED VOCATIONAL TRAINING SERVICES

Besides from the architectural model, which is transparent to the end users, a basic issue of distance learning and training systems is the selection of the services that will be provided to the users for allowing and facilitating the corresponding processes. These services need to be selected, designed and implemented based on the special needs of the users they target. To this direction, this section presents the functional requirements of a Web-based training system, in the sense of the design characteristics and of the services that such a system should provide and support.

Based on the requirements of vocational Web-based training and the design characteristics, this section presents the services that the integrated architecture should combine for meeting the needs of vocational centers and of the trainers. The vocational training services are divided in the following basic categories: (1) synchronous communication services, (2) collaboration services, (3) asynchronous services and (4) content related services. These services should satisfy the criteria for pedagogical and technological innovations in vocational training environment. For satisfying these criteria the available services should be designed and implemented as modules that could support an adaptive learning environment not only to the VET organization needs but also to the users' needs.

Table 2 presents what services satisfies which requirement. These services are presented in detail in the following paragraphs.

Synchronous Communication Services

The main synchronous communication services are text and voice chat:

- **Text Chat:** This feature allows two participants to communicate in a synchronous mode. In a vocational training system text chat can be used by trainees, which do not necessarily take the same classes or courses as a means of social communication and interaction. In the framework of a collaborative training environment, text chat can be proven to be extremely helpful for trainees who can meet out of classes and discuss issues that concern them, pose questions, and generally interact without being supervised and rated. In addition, a group, of people who share common interests, can create its own chat rooms. Also, this component. Text chat could be found in many forms, as public and private chat rooms or as public chat, where all participants can view the messages being exchanged and whisperings, where the communication is realized only between two peers. In a vocational training synchronous session, text chat could be integrated so as to allow participants to pose questions to the trainer or comment the content being presented.
- **Voice Chat:** This service allows users to communicate through audio by using a microphone and speakers. Voice chat in a training system can be used for the delivery of a training course but mainly it is used as a supporting tool for the communication among the participating peers and in many cases floor control by the trainer should be available for a more effective coordination of the training and communication process.

Table 2: VET environment requirements and services

Requirements \ Services	Text Chat	Voice Chat	Shared whiteboard	Application sharing	Slides creation and presentation	Multimedia presentation	Video Conference	Intelligent agents	E-mail	Forums	Glossary of terms	Calendar of events	Access to learning content, Content creation, Content manipulation	Manage Trainees, Manage Trainers, Manage Courses, Manage Lessons, Manage system modules
Reflection, Exchange & Activeness	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
Scaffolding, Storyboarding & Constructiveness			✓	✓										
Facilitation and Cooperativeness	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓
Content					✓	✓					✓		✓	
Monitoring and Assessment								✓						✓
Investigation & Problem based			✓					✓						✓
Community										✓		✓	✓	✓
Recognize the prior learning of the trainees								✓						
Contextuality				✓										✓
Interactivity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓
Communicativeness	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓
Individuality								✓					✓	
Multimedia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓

Collaboration Services

The main collaboration services are shared whiteboard, application sharing, slides creation and presentation, multimedia presentation, video conference and intelligent agents:

- **Shared whiteboard**: The whiteboard supports line, circle and ellipsis drawing in a wide range of colors and text input in many sizes and colors. It can also offer "undo last action" capability as well the erasure of all previous actions on the whiteboard.
- **Application sharing**: This service allows a moderator (usually the trainer) or participant to share any application, a specific region on the desktop or the entire desktop with other attendees. The host of the application can grant remote control of his or her shared application(s). This allows for true hands-on training, demonstrations and support applications.
- **Slides creation and presentation**: This tool allows the creation of slides by participants of a session, where only one participant can add information on the slides table. However, the slides presentation is viewed by all participating peers.
- **Multimedia presentation**: This service is used for the presentation in various formats (text, video, flash files, etc.) of information relevant to the objectives of the vocational training course. For example, the multimedia presentation could be used for the projection of a video which shows in detail the functions and problems of a complex system or machine.
- **Video Conference**: This service can be used for supporting not only communication (as text and audio chat) but also for the collaboration among the participating peers using open and private meeting rooms. This service, when used in a training system, either uses the video for the representation of the trainer, who delivers the course, or with the video representation of all participants of the same session. In most cases, this type of service consists of additional tools, which are integrated so as to constitute a completely functional service to the end user. It should be mentioned that in particular, some of the tools integrated in video conferencing services are:
- **Intelligent agents** for assisting the users during the synchronous sessions: as mentioned above, the majority of the trainees in vocational training centers are adults with little or no knowledge on the subject in which they are trained. The introduction of the technology for providing courses can additionally burden the effort of the trainees and discourage them on using the system. For avoiding the discouragement of the users, intelligent agents can be adopted, which monitor the users' behavior in the synchronous collaborative session, in terms of the actions they perform and the degree of participation they present. When the users' performance in certain categories falls under a certain limit, which can be set according to the area of Web-based training, intelligent agents can produce messages that trigger the users to participate or even propose "action" paths that the user could follow for facilitating the training process.

Asynchronous Services

The main asynchronous services are e-mail, forums, glossary of terms, calendar of events, and intelligent agents:

- **E-mail**: This service is the most common and widely used among users. E-mail allows the asynchronous communication among peers, which have the ability to write their opinions, pose questions and attach files. In a vocational training system, e-mail can be

used for the communication among trainees as well as a means for contacting the trainer in order to pose questions or for submitting reports and assessments.

- **Forums** (structured and unstructured): It is a tool, which aims to support asynchronous communication among the community members in order for them to exchange views and information. It supports open and closed moderated forums for the whole community as well as subgroups of members. In order to motivate the users' discussions in a more convenient way a notification for every post of the forum is sent to the forum members by e-mail.
- **Glossary of terms**: This service could be considered as an online dictionary with terms relevant to the topic of interest. Especially in vocational training, where the areas of training can significantly vary, this service can be proven very beneficial for trainees who need to obtain some basic knowledge on the basic terms used in the field they are trained on. The glossary of terms tool provides the name of the term and a short or more detailed description of the explanation of this term, the concept it aims to describe and the context it can be used.
- **Calendar of events**: The calendar of events is a timetable that stores a collection of events and lists them in chronological order. It is an asynchronous mean of communication, which can be used for the scheduling of events that take place in the Web-based training system. Each user can dispose a private calendar of events, which means that only this user can see the contents and posts in this calendar. The calendar can support three types of events: public, private and related to each training course. In the public calendar of events the users can post their announcements to the administrator, who in turn, will decide if the announcement is "qualified" to be posted. Furthermore, there can be a course calendar that includes class schedules and venues, schedules assignments, examinations and topics to be covered. The calendar consists of three views. The day view, which is also time scheduled, the month view and the year view.
- **Intelligent agents** for matching users' profiles and encouraging the communication and collaboration between them: as the term indicates, a collaborative training environment should motivate the communication between its members. In particular, better communication can be achieved between members who share common ideas and interests. Therefore, every member of the system, at the time of his/her subscription to the system enters personal information, which includes his/her interests, hobbies, the research/work areas, which s/he prefers, etc. Thereby, a profile for each user is created which is constantly enriched with additional information, which arises from the selection of courses that s/he decides to attend. An intelligent collaborative Web-based training environment should be able to match users with common interests and encourage the communication among them. This functionality could be achieved with multiple queries in the users' profiles and selections of courses in order to track down areas of mutual interest, which will contribute to the distribution and extension of knowledge. In addition, a system should be able to compare the users' profiles, and especially the fields of research interests, with the available courses and suggest some possible alternatives. These functionalities could contribute to an interplay between the members and the system, which in turn could result in effective distribution of knowledge.

Content-Related Services

The main content-related services are: access to learning content, content creation, and content manipulation:

- **Access to learning content:** This service allows the trainees to view the provided learning content. However, the access to learning content may vary from system to system or among training courses in regard to the navigation paths that the user can follow. In particular, in certain courses the trainees could be able to follow a linear path for accessing the content while in other cases, where certain variables are used the trainers are sent to different directions based on training criteria or responses to specific questions. Courses created using variables are more complex to design, but they account for a range of knowledge and skill sets.
- **Content creation:** This service enables trainers to integrate an array of media to create professional, engaging, interactive training content relevant to the area of learning and training. Even though content used to consist of simple, independent files, as documents, videos and presentation, the current trend requests for content creation services, which are compatible with educational standards, as AICC, SCORM, IMS and LRN. This option makes possible the repurpose of digitized elements or learning objects from an existing training course for reuse in a new one (Harris, 2002). Furthermore, content creation services are not related only to the information that will be presented to the end user (trainer) but also to the creation of the necessary question types (fill-in-the-blank, matching, true or false, short or long essay) for evaluating the trainer's performance and understanding on the content being delivered to him/her.
- **Content manipulation:** A simulation of a training course presupposes that the trainer has the capability to add and manage learning content, which could be dynamically changed, and dispose knowledge to the trainees, providing them the capability to have and process this learning material. In addition, there could be no efficient simulation if the trainees did not have the capability to maintain their own notebook, which in terms of a Web-based training environment means a directory with files and folders for personal use. Such functionality can be supported with two basic operations, the uploading and downloading of files, in the framework of the vocational training environment.

Administrative Services

The main administrative services are the management of trainees, of trainers, of courses, of lessons and of the system modules:

- **Manage trainees:** This service allows to the organization (vocational center) to administer the registered trainees in terms of being able to view their profiles and create reports regarding the trainees' skills and performance in various assessments. Furthermore, the administration of the trainees is also related to their assignment to course cycles and lessons being offered by the online vocational training system.
- **Manage trainers:** The trainers constitute one of the most vital entities of the VET system, who, based on their skills and educational background undertake courses in the online system. This service enables the organization to keep a record of the trainers available as well as of the profile of these trainers and based on these data it enables the assignment of at least one trainer per lesson.

- **Manage courses:** As mentioned in the previous section, the vocational Web-based training system could be engaged to various fields of education and training. Each of these areas is comprised by a set of courses, which in turn can contain a number of lessons. This service allows the organization the creation of new courses, the deletion of outdated courses and the general administration of the information related to each course.
- **Manage lessons:** This service enables the organization to administer the lessons available within the provided courses. The administration, alike the case of the courses, is related to the ability of creation of new lessons, the modification of existing lessons as well as to the deletion of outdated or no longer relevant material.
- **Manage system modules:** This service provides to the organization full access to the system, in which it can add, remove and modify functionalities and fix possible feeblenesses of the system.

SYSTEM ARCHITECTURE

As mentioned in Molter (1998):

An architecture comprises a set of views on different characteristics of the system. Among these are structural views on different abstraction levels, describing, for example, the highest-level decomposition of the system into components, which collaborate by using connectors, object-oriented models of the system, and its module architecture. Each level of structural description defines a specific set of component and connector types, as well as rules and constraints describing specific constellations of instances of these types. The definition of component and connector types also comprises the description of their semantics and communication protocols.

The architecture of a VET online system should be based on the following principles:

- Ease of installation and usage concerning users' side: support of the most common Web browsers.
- Support of standardized Web services.
- Open standards, modular and extensible Web-architecture.

An n-tier application architecture could support the above principles by providing a model to create a flexible and reusable application. In this type of architecture each application is broken into tiers or layers. Therefore, when there is a need to change the presentation or scale of an application, the programmers have only to modify a specific layer, rather than have to rewrite the entire application. Thus, this solution is cost and time effective. Other benefits of such a solution are:

- Support of thin clients, which means that the users are able to run the user interface on less-powerful machines.
- Reduced maintenance, because the possible changes are applied only to the required components.
- Reusability by using existing components and tiers to provide services to new applications.

As mentioned in the previous section, the proposed system architecture combines synchronous, asynchronous and collaborative services into one unified, integrated platform for meeting the needs of vocational Web-based training. Thus, our proposal is an n-tier architecture based on several components, which communicate and interact for providing the desired and needed functionality. Our n-tier architecture has the following layers:

- Presentation layer (or client side), which is responsible for displaying user interface and

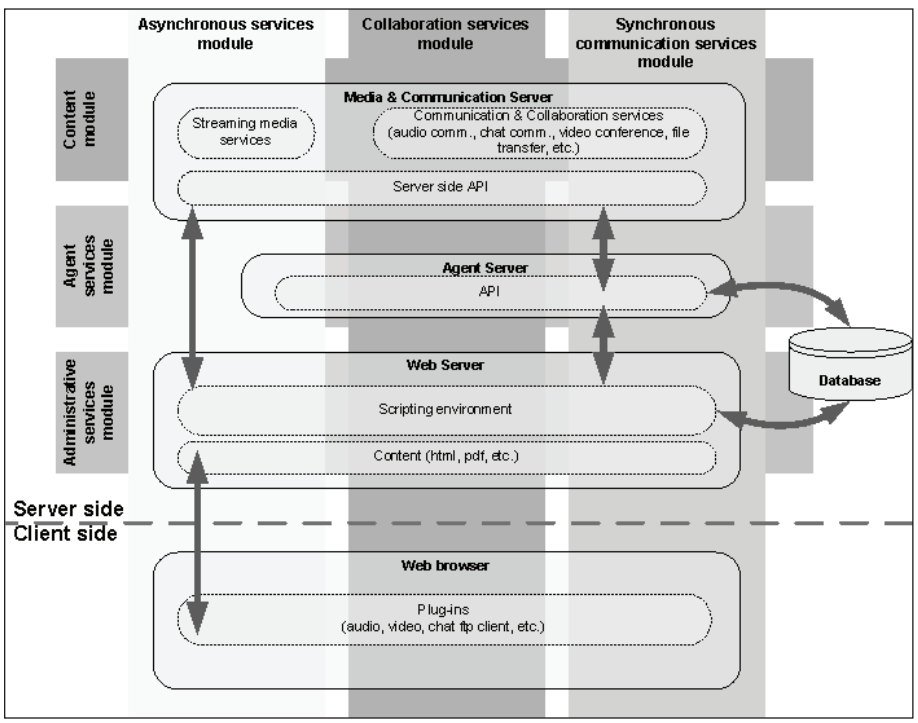
"driving" that interface using business layer rules.

- Business layer (part of the server side including application and Web servers) which implements the logic of each application. More specifically, it manages the business rules, the data, custom and user controls, etc. It handles access to the data layer to retrieve, modify and delete data to and from that layer and sending the results to the presentation layer.
- Data layer, which is the database of the system.

Furthermore, the system should be based on a variety of communication protocols, be scalable, be platform independent and be based on open standards. Figure 2, presents the integrated architecture, which consists of various components/modules, each of which supports certain types of functionality. These components are described in the paragraphs that follow.

As mentioned, the integrated platform comprises three basic modes of interaction: synchronous, asynchronous and collaborative, which are depicted in Figure 2 as the vertical dimension. In each of these modes, there are a number of provided services for providing, supporting and maintaining the tele-learning process which were described in the previous section. Apart from these services, there are additional tools, which are related to: (1) the creation, provision, access and distribution of the content, (2) intelligent agent support for facilitating the training process and promoting user participation and (3) administrative services for allowing the organization to manage the entities of the system as well as the provided services. These three types of tools can be based on services that run on all three types of interaction (synchronous, asynchronous and

Figure 2. Integrated system architecture



collaborative) and are therefore depicted in Figure 2 as the horizontal dimension.

From a more technical point of view the systems is comprised by the server side, which contains all the functionality and services and from the client side, which comprises the components needed for the user to access and interact with the system.

Server Side

The server side consists of all the necessary components for the provision and support of different types of services. In particular, the proposed system is comprised by the following components/servers:

- **Web server:** this server contains all the asynchronous system features and acts on server side as an integration platform through an extended API. This server supports the core of the scripting environment as well as a content repository, which allows managing several kinds of documents and works as a document archive, which stores, archives and retrieves documents.
- **Multimedia and communications server:** This server interferes with all modes of interaction. In the synchronous and collaborative mode, the server supports the corresponding services, while in the asynchronous mode the server is used for supporting streaming media provision. Furthermore, this server comprises also the necessary API for the interaction and communication of this server with the other components of the system.
- **Agent server:** The agent server supports all the necessary functions for the intelligent support of the system to the end users and is also applied to all three modes of interaction. For the transparent to the user integration of these functions, the server communicates through the API with all other components of the system.
- **Database:** The database constitutes the major information repository of the system, which manipulates user and content information as well as data for the intelligent agent support.

Client Side

The client side consists of all the necessary components, which allow the end user to access and interact with the system. For the proposed system, the user can access the system through a Web browser. However, given the fact that multiple modes of interaction are supported, the Web browser should be enabled with the necessary plug-ins. These plug-ins mainly concern the synchronous and collaborative part of the proposed system as well as the agent component. Thus, the Web browser should provide the necessary plug-ins for audio, video and chat communication as well as an ftp client.

CONCLUSION

This chapter investigates the current situation on ICT-supported VET, the current trends in online VET technologies and the vocational training characteristics and requirements. According to this investigation, it seems that e-learning technologies can help the vocational education and training students and teachers. The review of the current trends in online VET technologies indicate that even though there is a majority of platforms and tools available that could be adopted for conducting and facilitating certain types of Web-based training processes, there is no integrated solution and architecture that combines all the necessary services into one platform. Therefore, an integrated solution that could provide and support a set of synchronous, asynchronous and collaborative technologies would be more effective for the Web-based training process, as it could assist and facilitate both trainers and trainees as

combinations of different types of tools could be adopted according to the topic of interest.

This chapter presents also a development framework that will be used as the basis for the functional and technical development of such an integrated online VET system.

According to that framework an integrated e-learning architecture for supporting vocational education and training has been described. This architecture aims to be the basis of an integrated vocational e-learning system, giving emphasis in pedagogical, administrative as well as the technological texture of such an e-learning place. Therefore, the platform is constituted by a number of interlinked components, each of which supports certain types of services for providing to the participating users an integrated learning environment. The variety of learning services that could be supported by this architecture, in the asynchronous, synchronous and collaborative mode will facilitate the students and participants of the e-learning environment to engage in VET programs.

FUTURE WORK

The next step after the description of the current architecture is the implementation of a working prototype based on this architecture. This prototype will include only basic features of the final system and will be used for formative evaluation by the end users. After that, the introduction of additional technological features and more advanced services will take place gradually in order to avoid the overload of the inexperienced users with new services whose added value is not clear to the users.

The final step is the launching of the final prototype, which will include the whole set of functionality and it will be ready for summative evaluation.

REFERENCES

Australian Flexible Learning Framework. (2005). *E-learning Benchmarking, Project—Report*, I & J Management Services, Australian Flexible Learning Framework (Framework), September 2005.

EduTechWiki. (2007). *Socio-Constructivism*. Retrieved October 20, 2006, from http://edutechwiki.unige.ch/en/Socio-constructivism

Harris, J. (2002). *An Introduction to Authoring Tools.* ASTD's Learning Circuits online magazine, Retrieved October 20, 2006, from http://www.learningcircuits.org/2002/mar2002/harris

Herremans, A. (1995). *Studies #02 New Training Technologies*. UNESCO Paris, ILO International Training Centre, 1995.

Levesque, K., Lauen, D., Teitelbaum, P., Alt, M., Librera, S., & Nelson, D. (2000). *Vocational education in the United States: Toward the Year 2000.* Washington, DC: U. S. Department of Education, Office of Educational Research and Improvement.

Manninen, J., Nevgi, A., Matikainen, J., Luukannel, S. & Porevuo, M. (2000). *Ohjelman tuottamat pedagogiset ja teknologiset innovaatiot.* Leonardo da Vinci Report.

Molter, G. (1998). *The notion of Software Architecture*. Retrieved October 20, 2006, from http://ww-wagss.informatik.uni-kl.de/Projekte/GeneSys/

OVAE. (2006). *Technology and Distance Learning.* Office of Vocational and Adult Education, U.S Department of Education, Adult Education and Literacy. Retrieved October 20, 2006, from http://www.ed.gov/about/offices/list/ovae/pi/AdultEd/tdlearn.html

OECD. (2003). *Beyond rhetoric: Adult learning policies and practice*s. Paris: OECD Publications, 2003.

Ramboll Management. (2005). *The use of ICT for learning and teaching in initial vocational education and training.* Final Report to the EU Commission, DG Education & Culture, November.

Seale, J. (2003). *E-learning accessibility practices within higher education: A review.* Paper presented at the British Educational Research Association Annual Conference, Heriot-Watt University, Edinburgh, 11-13 September 2003. Retrieved October 20, 2006, from http://www.leeds.ac.uk/educol/documents/00003152.htm

W3C. (1999). *Web Content Accessibility Guidelines 1.*0. W3C Recommendation. Retrieved October 20, 2006, from http://www.w3.org/TR/1999/WAI-WEBWEBCONTENT-19990505/

Wikipedia. (2006). *Vocational Education*. Retrieved October 20, 2006, from http://en.wikipedia.org/wiki/Vocational_education