Design and architecture of an online system for Vocational Education and Training

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Abstract:

E-learning and tele-training have been 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. 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, to the tools needed for the realization of the training process as well as to the familiarization of the target audience to the selected technologies. Basic aim of this paper is the description of a platform for open and distance training, which is mainly focused at supporting the needs of Vocational Training Centres as well as of institutions providing life-long adult training and learning. In particular, the issues that this paper focuses on are vocational education and training characteristics and requirements while it also proposes basic vocational training services and the system architecture of the integrated platform.

1 Introduction

Information and communication technologies (ICT) have been considered, from the early beginning, a facilitator to education and knowledge. The evolution of these technologies in combination to the emergence of new technologies over time as well as the high degree of familiarization of individuals with their use, offer advanced possibilities for learning and training. To this direction much research 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 at. 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, training with and in fast changing technologies as well as to the improvement of the instructional systems [1].
One of the cases that tele-training can be effectively adopted is the vocational education and training (VET). According to [2], VET 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 particular techniques or technology. However, as stated by [3], "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 [4].

As the labour market becomes more specialised and economies request more skills, governments and businesses are increasingly investing in the future of vocational education. However, there is a large number of individuals, who cannot participate in such 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 substitute the traditional VET process) could be very useful [5]. In addition, to this direction many tools have been developed for supporting and assisting the realization of the tele-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 paper 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: a) synchronous, b) asynchronous and c) collaborative:

- Technologies for synchronous real time communication among the participating peers, such as text and voice chat.
- Technologies for asynchronous learning and training, which mainly provide tools which were designed to complement conventional methodologies for dissemination of course content, without supporting synchronous collaborative activities.
- Technologies for collaboration, which are mainly related to real time multi-user applications and allow an advanced degree of interaction among the participating peers. 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.

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 tele-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 tele-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 tele-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 tele-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.

Basic aim of this paper 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 paper is structured as follows: Section 2 describes the basic vocational training features, characteristics and requirements so as to define the differences and differentiations in regard to other types of education and for extracting the needs and motivation of the target users. Section 3 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 previous section. Section 4 is engaged to the description of the system architecture, in terms of the logical view of the static structure of the architecture, the dynamic behaviour of the system in terms of the specification of the system behaviour, collaboration of components for achieving the system behaviour and the physical view of the tele-training system related to the deployment of the system. Section 5 summarizes the paper and it presents the planned next steps.

2 Vocational training characteristics and requirements

The starting point when designing and developing an e-learning or tele-training system is the identification of the special characteristics of the users it targets at and the objectives it aims to achieve. In the case of vocational training the users of an e-learning vocational system are trainees (mainly adults with some knowledge on the theme area that they will be trained on, who also 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 variations 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.

2.1 VET features

According to the current situation concerning VET programs offered today worldwide, we could present the following general features of VET: a) VET covers education and training useful both before and during employment, b) VET includes both craft-based training and industry-wide training, c) VET is provided in institutes and in the workplace, d) VET programs could range from basic level and skill-specific courses to more advanced and broader courses awarding qualifications such as advanced diplomas, e) 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 young individuals. This implies learning that is learner centered and contextualised 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 characterised by the following functionality [1]: 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 [6]. 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. [7] has presented criteria for pedagogical and technological innovations in vocational training environments. The criteria for pedagogical innovations in

vocational training environments are the following: a) Constructiveness: Teaching and learning are clearly based on the learners' active construction process and on the higher-level knowledge structures, b) Activeness: Learning environment is based on the learner's active role and commitment, c) Cooperativeness: Learning is based on co-operative and collaborative principles and takes place in groups, d) Contextuality: Learning takes place in a simulated or real-life situation, which equals the actual context where the knowledge will be applied, e) Problem based: Learning approach is problem based and investigative.
The criteria for technological innovations in vocational training environments are the following: a) Interactivity: Tools are based on interactive technology (interactive video, interactive www-pages, learning programs), b) Communicativeness: Tools allow many–to–many-type communication. In an ordinary VET environment tools allow many–to–many-type communication, c) Individuality: The tools make it possible to create and follow individual study paths, d) Multimedia: The product is an innovative combination of alternative tools supporting each other.
According to the above we can extract the basic requirements and characteristics of an online VET system, which are described in the next paragraph.

2.2 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 centres we should extract the design characteristics for the following entities (stakeholders): (a) Vocational centre administrative staff, (b) Trainers, and (c) Trainees.
From the perspective of the vocational centre administrative staff, an online VET system should:

- Allow the vocational centre to serve a greater number of trainers and trainees: the online substance of the tele-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.
- Allow the vocational centre 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 tele-training course.

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.
- 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.

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.
- Provide effective tele-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 tele-training processes, which will facilitate trainees in completing these processes.
- Promote the personalized nature of the tele-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.

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 [8] 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.

3 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 at. Based on the requirements of vocational tele-training and the design characteristics, this section presents the services that the integrated architecture should combine for meeting the needs of vocational centres and of the trainers. The vocational training services are divided in the following basic categories: a) synchronous communication services, b) collaboration services, c) asynchronous services d) administrative and e) content related services. These services are presented in detail in the following paragraphs.

3.1 Synchronous communication services

The main synchronous communication services are text and voice chat.
- Text Chat: This feature allows to 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.
- 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.

3.2 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 shared whiteboard is a simulation of a classic whiteboard located in a classroom. It will be used for supporting an online lecture or collaboration of a group.
- 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.
- Multimedia presentation: This service is used for the presentation in various multimedia formats (text, video, slides, flash files, etc) of information relevant to the objectives of the vocational training course.
- 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, by using 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 (i.e. text chat, shared whiteboard, etc.), which are integrated so as to constitute a completely functional service to the end user.
- Intelligent agents for assisting the users during the synchronous sessions: as mentioned above, the majority of the trainees in vocational training centres are adults with little or no knowledge on the subject 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' behaviour in the synchronous collaborative session, in terms of the actions they perform and the degree of participation they present.

3.3 Asynchronous Services

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

- E-mail: 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.
- Calendar of events: The calendar of events is a timetable that stores a collection of events and lists them in chronological order. It's an asynchronous mean of communication, which can be used for the scheduling of events that take place in the tele-training system.
- Assignments/Tests: Assignments allow the trainer to specify a task that requires students to prepare digital content and submit it by uploading it to the server. Typical assignments include essays, projects, reports and so on. Tests allow the teacher to design and set tests,

consisting of multiple-choice, true-false, and short answer questions. The trainer can grade the trainees work.

- 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 creates a profile, which is constantly enriched with additional information, which arises from the selection of courses that s/he decides to attend. An intelligent collaborative tele-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 be tracked down areas of mutual interest, which will contribute to the distribution and extension of knowledge. These functionalities could contribute to an interplay between the members and the system, which, in turn, could result in effective distribution of knowledge.

3.4 Content Related Services

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

- Access to learning content: It 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.
- Content creation/integration: It 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 [2].
- 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.

3.5 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 Centre) 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 previous section, the vocational tele-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 to 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.

4 System Architecture

As mentioned in [9] "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."

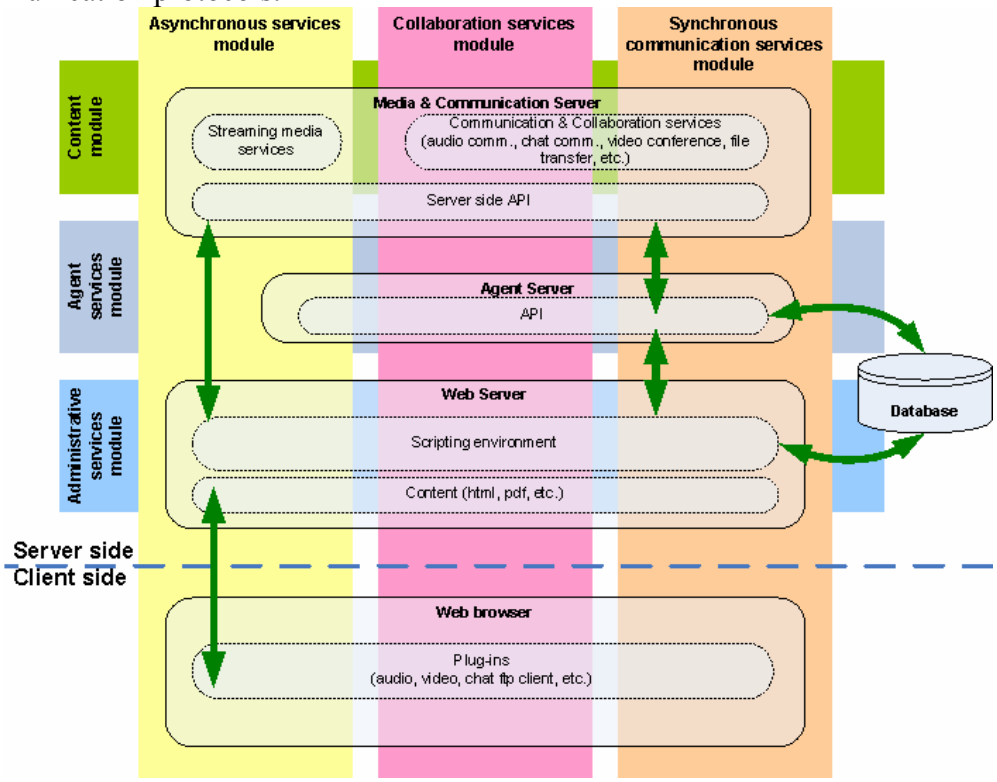

Figure 1. Integrated system architecture

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 tele-training. Thus, our proposal is an n-tier architecture based on several components, which communicate and interact for providing the desired and needed functionality. Furthermore, the system should be based on a variety of communication protocols, be scalable, be platform independent and be based on open standards. Figure 1, 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 1 as the vertical dimension. In each of these modes, there is a number of provided services for providing, supporting and maintaining the teletraning process, which were described in the previous section.
Apart from these services, there are additional tools, which are related to: a) the creation, provision, access and distribution of the content and b) intelligent agent support for facilitating the training process and promoting user participation and c) administrative services for allowing to 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 collaborative) and are therefore depicted in Figure 1 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.

4.1 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.

4.2 Client Side

The client side consists of all the necessary components, which allow to 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, which mainly concern .the synchronous and collaborative part of the proposed system as well as the agent component.

5 Conclusions

This paper 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 could assist and facilitate vocational education and training of 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 tele-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 tele-training process.
Furthermore, this paper presents an integrated e-learning architecture for supporting vocational education and training. This architecture aims to constitute 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 type of services for providing to the participating users an integrated learning environment.
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. 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.

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