PEDAGOGICAL PRINCIPLES FOR ACTIVITY BASED TRAINING METHODOLOGIES

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ABSTRACT
This paper outlines and discusses pedagogical approaches, teaching principles and learning design of industrial oriented skills upgrading processes utilizing video based training sessions, blended learning methodologies and Activity Based Training (ABT). The educational processes may utilize videoconferencing and/or high quality video streaming. ABT training courses are structured in a number of orders with subsequent work packages that improve knowledge and competence transfer according to a just-in-time job production workflow approach, where theoretical and practical training follows each other closely. ABT merge blended learning methodologies mixing on-site training with self-paced learning through e-learning, and inclusion of state of the art visual communication and collaboration solutions, e.g. industrial video streaming. Welding trainers and welders working in mechanical industry or Small and Medium sized Enterprises (SME), constitute model user groups. The pedagogical principles as well as ABT principles may be utilized in company skills upgrading processes where the production workflow is divided into work packages.

KEYWORDS
e-learning, learning design, welding, mechanical industry, video streaming, video, videoconferencing, activity based training, work package, order, distance learning

INTRODUCTION

The Pressure Equipment Directive arises from the European Community's Programme for the elimination of technical barriers to trade and is formulated under the "New Approach to Technical Harmonization and Standards". Its purpose is to harmonize national laws of Member States regarding design, manufacture, and testing and conformity assessment of pressure equipment and assemblies of pressure equipment. It aims to ensure the free placing on the market and putting into service of equipment concerned within the European Union and the European Economic Area. Formulated under the New Approach the directive provides a flexible regulatory environment that does not impose any detailed technical solution. This approach allows European industry to develop new techniques thereby increasing their international competitiveness. The introduction of the new legislation related to pressure equipment concerns a large number of industries ranging from small and middle-sized manufacturers to the big chemical industries. Their total European market is estimated to be € 65 billions per year. It is expected that deployment of new types of Activity Based Training (ABT) methodologies (Stav, 2006 a-c and Engh, 2006) founded on industrial production workflow and promotion of European harmonization of training principles, may help speeding up the necessary transformation process. Inclusion and use of ABT requires that theoretical and practical training follows each other closely, and that the training schedule follows the production path of a particular structure or product. The student’s access when needed during the training process, learning material stored in various media formats before they proceed to the next training element. Finally, inclusion of a blended learning approach offers different delivery technologies for the contents. Examples of educational activities exploiting video resources include (i) user guides targeting welding processes, and use of complex and expansive welding equipment, (ii) industrial examples connecting complicated theory to

real world welding processes or phenomena, and (iii) “vivid illustrations” offering the teacher, learner and student access to a fast and cost-efficient service demonstrating how a process proceeds, how equipment is going to be used, or the effects of a physical principle.

The harmonization process and the specifications related to training principles may include elements like:

- Harmonization of the curriculum according to joint industrial specifications in the mechanical industry sector as well as Small and Medium Enterprises (SME).
- Harmonization of skills transfers processes between and within SME personnel, e.g. different types of welder personnel, mechanical industry workers, and train-the-trainers that may access educational material and e-learning services according to standardized principles for learning design.
- Establishing a set of European quality criteria for identification of mechanical industry and SME learning needs within an ABT educational perspective. It is expected that joint European standards for the curriculum constitute the basis, including development of innovative e-learning content.
- Continuous training and deployment of level specific standardization practices to the teachers and trainers working in the mechanical industry or SME, by innovative use of blended learning tools and services. Inclusion, use and deployment of high quality H.264 video solutions offer quality assurance as well as verification tools for the training process.
- Development of model recommendations containing a core set of European training modules utilizing high quality video based material, e.g. industrial streaming video (or DVD) solutions, that may be easily distributed throughout Europe.
- Establishment of a Quality Assurance and Quality Control system for the training principles, training infrastructure, as well as ABT content specifications for the training courses.

ABT targets especially the needs for certification based training processes (Stav 2005) and transfer of competence to personnel working in SME and the mechanical industry sector. Competence is defined as “the ability to meet demands or carry out a task successfully, and consists of cognitive and non-cognitive dimensions” (DeSeCo, 2002). The mechanical industry sector includes highly specialised and innovative SME that must certify their personnel according to harmonized European specifications. Unfortunately, too many SME lack indeed knowledge about the harmonization of skills transfer principles, as well as how they shall promote solutions offering easier deployment of level specific industrial production knowledge to other areas and fields. It is for instance expected that certain SME markets are going to grow during the next years due to extended access to European wide production systems such as for instance fabrication of plastic pipes and structures of plastic pipes. SME are expected to develop a wide range of new products spanning from simple products into a range of high technology products that will emerge through research and innovative product development processes. Some of the first target applications for the new training methodologies may be within distribution of gas. This includes the piping network for central gas distribution with hubs and supplying services, as well as the gas distribution to the customer. Training may cover a wide range of piping products related to the piping diameter, wall thicknesses, and the transport pressure itself. Furthermore, ABT may also target areas like waste removal and management of contaminated water where especially in Eastern Europe the distribution infrastructure must be renewed and enhanced due to lack of existence or maintenance. This includes both dimensional problems and challenges related to corrosion. SME often act as independent contractors or as governmental agencies specializing within waste removal etc.

BLENDED LEARNING FRAMEWORKS

Distance learning services provide us with an opportunity to offer and deliver education and training to geographically distributed end-users by making it more attractive and cost-efficient. Advanced distance education and training solutions offered to groups of students may utilize a blend of learning technologies. Pedagogical methodologies often utilize a blended learning and training solution that constitutes of the following training elements:

- Traditional classroom structured instruction with face-to-face training where the trainer(s) and the students meet
- Self-paced learning through Learning Management Systems (LMS)
- Hands-on practical training and collaborative laboratory work
- Inclusion of various Visual Collaboration and Communication (VCC) services offering high quality multipoint real time communication to groups of students by using video streaming and videoconferencing

Streaming video offers one-way audio and video communication to several locations at the same time. The end-users join a training session by using the browser (real time streaming), or as video on demand when it is needed during the training process. Modern videoconferencing systems offer real time streaming of the session. The streaming video solutions may, by utilizing a special infrastructure, present both a recording of the teacher and the presentation which was given.

Videoconferencing offers a communication and collaboration environment where audio and video are transmitted in real time between two or several locations, across, in principle, unlimited distances. Many videoconferencing systems communicate data in parallel (e.g. a Power Point presentation), whereby they are suited for distance training purposes. Instructional processes utilizing videoconferencing take advantage of the communication technology developments by offering real time face to face communication in distance teaching settings. It should be noticed; however, that videoconferencing as a standalone tool has rather limited effect in distance educational settings, since it only offers components of the training elements needed within skills upgrading processes and education. There is, however, numerous of successful frameworks, which combine videoconferencing with various e-learning solutions.

Proper inclusion of blended learning training principles requires special attention towards exploitation of digital video case libraries, videoconferencing and integrated technical solutions that may forward training to groups of students within one educational environment. This includes transfer of two parallel video streams displaying both the teacher and the presentation. Furthermore, pedagogical models must offer support for integration of interactive learning and training styles into distance training practices. This includes didactical implementation and recommendations for applying state of the art video services in teaching and learning (Stav, 2007a), delivery of an information base (Stav, 2007b) targeting video communication and collaboration tools and online services for the integration of new video technology into distance training, as well as a use of digital video case libraries (Meletiou, 2006) containing segments of real teaching episodes with educational high lights, obtained in the classrooms whereby they represent a landscape of practice through out Europe. The digital video case libraries offer teacher educators and teachers online professional development by utilizing their professional knowledge through learning activities exploiting short video clips with high quality video materials that have been recorded, edited and published online in order to offer trans-European easy access in a multilingual environment. The digital video case libraries targeting welding (Stav, 2006b) contain material that may be classified as i) Laboratory type videos, ii) Equipment type videos, iii) Instructional examples, iv) Case-oriented videos v) Action videos, vi) Video-tour, and vii) Conceptual videos.

The pedagogical framework is adapted to ABT and the specifications (IIW, 2005) developed by the International Institute of Welding and the European Welding Federation (EWF). This document is the Guideline for International Welder education and creates a framework for harmonized education in Europe as well as internationally. The EWF represents an interest organization with more than 60.000 companies in Western Europe with more than 100 employees. This number has grown to 100.000 companies after the EU expansion. Welding companies, or fabricators, are in need of highly skilled personnel to meet the requirements of the industry. Thus, welders must be trained both theoretically and practically according to the EWF guidelines.

PEDAGOGICAL FRAMEWORKS

In ordinary classroom teaching there are many different opinions targeting why some teachers are considered as being more successful than others. Evaluations offered by students will frequently contain common characteristics targeting the training processes, such as:

- Engagement and professional interest of the subjects
- Use of structured documentation and presentations
- Loud and clear speech and understandable handwriting
- Use of variations at a large scale, all from variation of voice volume to variation of presentation formats
- Presentation of the curriculum in an engaging and relevant way
- Able to establish a two-way communication process towards the students
- Able to show human aspects behind the professional trainer

It is easiest to offer training targeting the first bullets points, and it is easy to observe measurable improvements within these areas. However, further down at the list it becomes more challenging as it may require a lot of training and development at the personal level in order to improve the training. The last bullet point differ from first six ones, which indeed mainly are connected to techniques and training methodologies. To show the human aspects behind the professional trainer requires a different type of courage and honesty. This is usually not a quality that may be developed through a course, but rather a lifelong training process that gradually establishes a totality for the teacher as a human and a trainer. Usually only a limited number of persons receive such qualifications from nature, so to say, as almost all the students sense the charisma immediately when the trainer is present in the audience. However, most teachers need to practise and train systematically in order to improve their knowledge transfer.

In videoconferencing teaching all these factors are still important. In fact, each aspect is a bit more important than in ordinary teaching, and the ability of creating an open communication is of fundamental importance. It may be quite challenging to obtain all this within a videoconference based training activity. The key word is training, both for the teacher and the students. Normally, we see that students don't feel comfortable with videoconferencing teaching before they have participated at least 3 – 5 times.

In addition, there are technical challenges that strongly influence the outcome of a video lecture. The variety of screens/monitors, audio equipment and technical infrastructure at the far end locations may, in fact, lead to consequences such that the video picture of the teacher and presentation of multimedia material are not displayed as meant or, even worse, not shown at all.

Though video and multimedia rich learning environments have the potential to improve learning in different ways, the literature has not always succeeded in providing explicit or decisive conclusions with relation to the impact that multimedia technology has on learning. Until recently (Samaras, 2006) it failed to recognize a broader range of parameters like the knowledge level of the learner, the intrinsic cognitive load, support from the multimedia learning environment and cognitive processes encouraged of learners by the environment.

ACTIVITY BASED TRAINING

A typical mechanical industry fabrication process utilizing welding is often given as an order which is divided into a number of work packages (se Figure 1). A work package is a detailed and sequential description of the working task that is going to be done and it is normally divided into one or several activities (Engh, 2006). Delivery of the final welded product requires a number of steps from fetching the material, through cutting it into smaller pieces which will be assembled and welded to a new product. These sequential activities will contain both theoretical and practical tasks which also include quality assurance and quality control of the job itself. The work package contains at least the following task information in order to secure that the process can meet the required quality: (i) Work drawing(s)

showing the structure of the final fabricated object, i.e. specific details and information for the tasks. (ii) Work description(s) covering how to do the job and which methods that are going to be used in the production. This includes work process description(s) containing the pre required knowledge, the working processes needed in order to produce the final product, and work package description(s) covering all the work that is going to be done. (iii) Quality requirements for the product to be produced and delivered. This includes quality assurance requirements for the ingoing elements, and quality assurance descriptions and requirements for the outgoing elements.

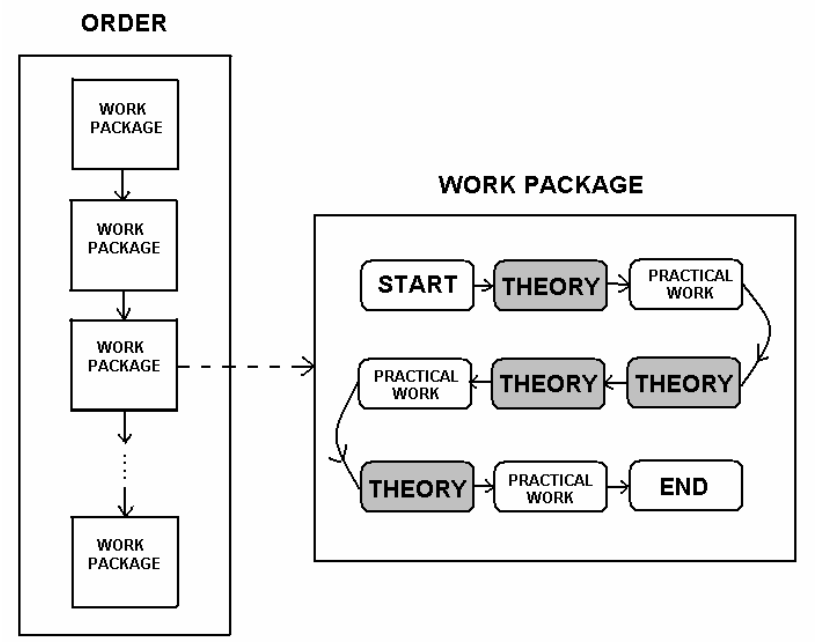

Figure 1. A mechanical industry order contains a number of work packages.

Figure 1 displays an example of an order structured into different work packages. Work packages consist of separate activities, which may include transfer of specific knowledge and training, as indicated in the figure. The training is carried out in the classroom (theoretical training), shop (hands-on training and practice), or in other production areas.

The pedagogical framework utilizes activity based learning in combination with harmonized content as defined in the international guideline (IIW, 2005). This document is the Guideline for the International Welder Education and creates a framework for harmonized education in more than 30 European countries as well as in most countries in the world. The order is divided into several logical elements, i.e. work packages, which then follow the fabrication and production process.

SME and mechanical industries still frequently utilize traditional training methodologies where theoretical learning, practical training of skills and production are totally separated in time. Within such a pedagogical framework usually hands-on practice follows after the theoretical content descriptions. ABT, however, utilizes training that is closely connected to the practical production activities according to the production path of a predefined structure or product through orders and work packages. It is a fundamental principle that theoretical educational content shall be available and delivered through activity based learning services on a just-in-time basis when needed in the production sequence. The students enter new training elements by following a sequential structure, ensuring that theoretical content is directly relevant for the subsequent practical tasks in the production process. Different delivery technologies may be mixed and used for transfer of multimedia rich content, promoting a flexible, engaging and motivating blended educational training environment. The educational material is delivered as e-learning objects stored in various multimedia formats, though still standardized for presentations through a chosen learning management system.

IMPACT ON TRAINING IN MECHANICAL INDUSTRY

The combination of ABT, access to video resources and blended learning methodologies validate a new generation of training and educational activities. It offers the teachers, as well as the students, access to new training environments compared with what is frequently used today. Unfortunately, the educational resources needed (technical and pedagogical), are not available in all European countries today. The backbone for this new training framework must be implemented during the next years according to the recommendations given in the report "Strategies for digital learning resources" (UDF, 2005). This requires a higher degree of reusability and collaboration within the development and production of educational material, as well as distribution of content. If these issues are not addressed properly, only limited use of new educational technology can take place within the industry due to accelerating production and training costs. Likewise, it is expected that only content that is standardized and portable, as well as adapted for distribution through different learning management systems, may survive in the long run.

Experiences and traditions demonstrate that mechanical industries become increasingly specialized in their production, while at the same time taking place all over Europe due to globalization of the production. Thus in the future only a limited number of European training providers will be able to supply and deploy a full range of (highly) specialized welding-oriented courses to geographically separated organizations and their branch offices. One limiting factor will be the allocation of skilled and professional training staff in different regions in Europe, since centralization of training courses requires increased traveling, loss of production time and increase of production costs. These issues require development and deployment of educational technologies and training methodologies that may be harmonized into a European learning environment dedicated to welding. Successful initiatives may utilize a mixed variety of pedagogical frameworks combining on-site training, e-learning and visual communication and collaboration technologies like industrial streaming instruction oriented videos.

Training offered in combination with job and industrial production activities, is expected to be one of the best available training methods because it is planned, organized, and conducted at the employee's worksite. Such training will generally be the primary method used for broadening employee skills and increasing productivity. It is the responsibility of welding coordinators and managers of companies in mechanical industry to use available resources to train, qualify, certify and develop their employees. It is particularly appropriate for developing proficiency skills unique to an employee's job. Activity-based training falls within this category, since theory and practical skills transfer of training will be added by using the production workflow of real life products within the staff's own working environments.

The concept of worksite training has evolved with distance-learning courses provided over the Internet. Experiences obtained recently within industry demonstrate that too large proportion of information communicated through traditional training courses has been forgotten at the time the student needs to use the information in his or her work. The ABT methodologies turn the approach around, the main idea being that the student selects a training course when he/she needs the information and knowledge in his or her work. This concept has already partly become a reality through interactive e-learning training courses available 24 hours a day through the Internet. Increased access to worksite training within mechanical industry will have a major impact on how training is organized and delivered in the future. The ABT approach and blended learning and training methodologies, utilize a just-in-time philosophy. At the same time the training sequences are modeled such that they follow the production workflow by making up separate learning design elements that may be interchanged and regrouped according to the Learning Management Systems.

CONCLUSION

This paper presents pedagogical frameworks and teaching principles related to effective inclusion of video based training and blended learning training methodologies into Activity Based Training (ABT). The principles for ABT focus on delivering theoretical content when it is needed just in front of the

practical training tasks, linking directly theory and practice in order to create relevance and motivate the student, triggering ultimately reflective cognition processes. Such knowledge transfer is particular important within global production environments where it is necessary to transfer mechanical industrial company specific know-how and competence across large distances, often on a just-in-time basis, due to tight production constraints. The selected pedagogical framework is closely connected to the production workflow through learning resources utilizing orders, each containing a number of work packages. Theoretical training is done in the workshop, hands-on training and practice is done in the shop, while the practical training is done in the laboratory.

Indeed, experiences from industry show that welders to a large extent are recruited from a group of personnel that prefer to avoid theoretical training. Thus, the issue addressed by ABT is not which particular technology to utilize in a given teaching and learning situation, since the blended learning methodologies and pedagogical frameworks utilize many different services and technologies that may be adapted to different infrastructures, training environments and teachers skills. Nor is the main focus on how to integrate effectively use and re-use of learning objects in teaching and learning, since the video streaming approach offers trans-European online access to targeted and multilingual content. Rather the issue addressed by ABT is the long term benefit of initiating improved training environments that promote reflective cognition processes due to the close connection between transfer of theoretical knowledge targeting welding processes, and the follow-up through practical oriented training. This includes on-the-job worksite related skills transfer of training in combination with a pedagogical framework that closes the gap and removes the contradictions between theoretical content and training, and practical skills transfer processes. Furthermore, the knowledge and competence transfer may easily be forwarded to geographically separated and distributed companies. ABT principles may be utilized by company skills upgrading processes where the production workflow is divided into work packages.

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REFERENCES

DeSeCo (2002). Definition and selection of Competencies: Theoretical and conceptual foundations, [on-line] http://www.portal-stat.admin.ch/deseco/deseco_annual_report_2001.pdf

Engh E. and Stav J. B. (2006). Activity Based Training within in-Company Skills Upgrading Processes. Proceedings of The European e-Learning Conference, ECEL 2006, October 2006,Winchester, UK.

The L3 project [online] (2006), Pedagogical use of digital Learning experiences and Learning activities that may yield increased Learning outcome within Natural Sciences at Engineering Schools, http://www.hist.no/aft/l3

Meletiou-Mavrotheris M. and Mavrotheris E. (2006). Enhancing the Early Statistical Reasoning in European Schools by Building an Online Professional Community of Practice. Proceedings of International Conference on Information Communication Technologies in Education, July 2006, Rhodes, Greece.

Samaras H. et all (2006). Towards a New generation of Multimedia Learning Design and Research: Broadening Established Theories of Multimedia Learning. Proceedings of the IADIS International Conference on Applied Computing 2006, ISBN 972-8924-09-7, p. 447-451

Stav J. B., Tsalapatas H. and Engh E. (2005). New Models for Increasing the Effectiveness of In-Company Certification Training. Proceedings of The IADIS International Conference WWW/Internet 2005, October 2005, Lisbon.

Stav J. B., Tsalapatas H. and Engh E. (2006a). New Training Models for In-Company Certification Training According to EWF Guidelines. Proceedings of The 6th EUROJOIN conference, Santiago de Compostella, June 2006, Spain.

Stav J. B., Engh E. and Tsalapatas H. (2006b). New Models for Pedagogical Inclusion of High Quality Industrial Video Solutions within Distance Training Practices. Proceedings of The European e-Learning Conference, ECEL 2006, October 2006, Winchester, UK.

Stav J. B and Engh E. (2006c). Activity Based Training for Just-in-Time Transfer of Knowledge to Companies. Proceedings of CELDA 2006: Cognition and Exploratory Learning in the Digital Age, December 10-12 2006, Barcelona, Spain.

Stav J. B. and Engh E. (2007a). Deployment of Activity Based Training Models into Just-in-Time in-company Training, to be published in the proceedings of INTED 2007: The International Technology, Education and Development Conference, March 7-9, 2007, Valencia, Spain.

Stav J. B. (2007b) .A European Audio-Video Information Base, to be published in the proceedings of INTED 2007: The International Technology, Education and Development Conference, March 7-9, 2007, Valencia, Spain.

The International Institute of Welding Guideline (IIW 2005). The guideline document IIW IAB-089-03/EWF-452-467-480-481 rev. 3, Jan. 2005

UDF (2005) National Report: Strategier for digitale læringsressurser (Strategies for digital learning resources) to the Department of education, Norwegian Government, 2005.

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