COLLABORATIVE WORKPLACE LEARNING BY USE OF ACTIVITY BASED TRAINING METHODS IN MANUFACTURING INDUSTRY

John B. Stav, Gabrielle Hansen-Nygård, Kjetil Arnesen, Knut Bjørkli
Sør-Trøndelag University College, Trondheim (NORWAY)
John.B.Stav@hist.no

Abstract

Ongoing work for designing, developing and introducing product- and process oriented training methods within the quality assurance sector in Norway, Hungary and Romania, as well as the plastic welding sector in Hungary, Slovakia and Slovenia, is reported. The article discusses use of student response services in industrial production processes. This ensures cost-efficiency with respect to developing and reusing educational material.

Keywords: Activity Based Training, Student Response Systems, mobile learning, quality assurance training, welding.

1 INTRODUCTION

One of the largest bridges in Europe was recently produced at multiple fabrication sites through an outsourced production process. The surface treatment was clearly specified by the contractor according to given standards. However, the Quality Assurance (QA) humidity requirements were not understood in one of the sites, whereby the expected maintenance and renewal cycle of 30 years, actually was reduced to 5 years. Additional costs: 1.5 mill euro every 5 year.

The urgent need for new natural gas distribution systems in Europe become evident during the energy crisis in January 2009. It is important to improve the current limitations in the energy distribution system, as plastic welding defects are discontinuities, which present possible fracture problems followed by accelerating repair costs. Thus, it is necessary to enhance the attractiveness of VET education and training. This includes disseminating a new competence transfer model, a new measurable quality assurance system, and a new pedagogical principle for organizing, delivering, and deploying effective production technology transfer.

The MECCA pilot project (2005-07) [1] developed the new Activity Based Training (ABT) learning environment. ABT follows the industrial production process, and the students always produce a product during a course. ABT facilitates 1) a just-in-time on-the-job production workflow competence and knowledge transfer approach, 2) a pedagogical model where theoretical training is always immediately followed by practical training, 3) coordinated use of advanced video technology, and 4) industrial quality assurance management where students exchange their products during a course.

This paper aims at disseminating and raising the awareness of the new product and process oriented ABT learning and training environment [2]. It offers flexible and sound pedagogical delivery of level specific manufacturing industry Quality Assurance (QA) production process training to VET schools and SME organizations in Romania, Hungary, Sweden and Norway [3]. It is also used in education of plastic welders in Hungary, Slovakia and Slovenia [4]. Thus, use of ABT provides new methods for delivering in-company skills upgrading processes that reduce the costs related to competence and knowledge transfer, and enhances production competence and know-how transfer to VET schools. This includes:

- Education of QA VET instructors as Product Oriented learning environment advisers, as well to instructors that educate plastic welders
- Disseminate an innovative transfer system for in-company QA training of personnel, delivered on a just-in-time basis without distance limitations by utilizing video and brand new mobile learning technologies that utilize Student Response Technologies
2 ACTIVITY BASED TRAINING

It is important to address a general issue within upgrading of skills in lifelong learning processes: How to efficiently transfer advanced production process knowledge to students who are looking for a profession, which to a large extent has required practical training with a minimum of theoretical education and where the students have limited knowledge of theory? This is of particular importance in the quality assurance sector, and in the plastic welding industry where failures related to incorrect operating procedures result in complex repairs and increasing life cycle costs.

The Activity Based Training (ABT) methodology uses an alternative pedagogical approach to education and training of personnel in industry. ABT utilizes learning methods that mix and merge the following components into one competence transfer model:

- A pedagogical tool that utilizes ABT to produce a product by following the industrial production flow of an object in such a way that theoretical training is directly connected to practice.
- Onsite training where theoretical education is immediately followed up by practical training
- Self-paced on-line education, and high quality instructional video of learning material to institutes, SME and VET schools. The training method promotes the use of modern learning tools in vocational education and training such as quality assurance, quality management training, as well as in education of plastic welders.

Figure 1. Activity Based Training starts by receiving a technical and economical specification of the product (a pyramid in this example). The product constitutes of many small pieces (here: boxes) that is developed one by one, and put together into one product (here: the pyramid). In order to figure out how to construct the product, it is necessary to learn more theory, carry out practical investigations, and provide quality assurance of the components during the production.

The core idea behind the ABT [2] is that the student shall produce a product during the training course. This product can be anything that is related to an industrial fabrication process, or the quality assurance of that process. During the course the product will be produced by going through a sequential production process that consists of a number of steps that can be identified and be treated as stand-alone training elements. They are often referred to as work orders and work packages.

A typical mechanical industry fabrication process is often given as an order, which is divided into a number of work packages (see the boxes in 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. 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 meet the required quality:
• Work drawing(s) showing the structure of the final fabricated object, i.e. specific details and information for the tasks.

• 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.

• The quality requirements for the product to be produced and delivered. This includes quality assurance requirements for the ingoing elements, and quality assurance descriptions

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.

It should be noticed that local industry needs can be used to define the products, or local community needs for products could be utilized in the training process. For instance, a school could cooperate with local industries as subcontractors if the production is relevant for their education and training. Usually, the ABT course is organized in a number of work orders. The quality assurance (QA) training is organized in such a way that it follows ISO 3834, and at the same time the ABT for industrial production process training as scheduled in table 1. The quality assurance topics from ISO 3834 may be structured in the same way as an ABT course for industrial production.

The training method focuses on what is learnt at the end of the learning process, while at the same time it utilize a process oriented syllabus by focusing at the industrial production process through task based learning. Thus, the training regulations include demand for process-oriented implementation of training. The goal is to adapt training to requirements in real industrial work processes, and in particular identify skills that must be imparted during a course program:

• The product prescribed must have a clear definition and description such that it may be derived and produced in a company

• The training process promotes transfer of industrial competence where the student act within the industrial production framework of a company, and at the same time shape and change the training process such that it optimize quality assurance and quality management processes

This is going to help companies to adept their training to organizational as well as technological development inside their organization. The training methods specify training tasks, while the technologies used have to be adapted to the production processes inside the company. In this way the technology and production process available inside the company, become the standard of the training provided to a class, e.g. within plastic welding.

3 MOBILE RESPONSE TECHNOLOGY

As part of the Do-IT project [3] a new type of student response system (SRS) for next-generation handheld devices (such as iPod Touch or iPhone) is tested. It was originally developed in the KA3-ICT project EduMecca. The “Student Response System” (SRS) for mobile devices is an online service that provides a just-in-time training, learning and evaluation methodology, supported by the most recent mobile technology. Instructors get instant feedback on how well the students are paying attention to a training session, while students get instant feedback on their understanding of key concepts. The system has been tested and used by more than 60 universities, VET schools and high schools in and outside Europe. The mobile computing based SRS system provides an economic and cost effective solution by utilizing widely available mobile, wireless multi touch pressure sensitive hand held devices.

At college or university level, classes are quite large (often more than 60 students per class). Due to time constraints, it’s often not possible for the lecturer to interact directly with the students during the lecture. Furthermore, many students find it difficult or embarrassing to ask questions in class; which reduces the level of student-teacher interaction even further. Because of the lack of feedback during class, it’s difficult for the lecturer to assess how many of the students actually follow and understand what’s being taught. Conversely, from the students’ perspective, their understanding of the material is rarely put to the test during class – such tests usually take the form of written assignments and exercises, which are corrected and returned weeks later. In other words, neither the teacher nor the students have a good “real-time” indicator of learning effect.
Again, because of time constraints, the students are rarely given time to discuss and interact with each other during class. If a student finds it hard to understand what’s being taught in class, it is therefore difficult to gauge whether he or she is the only one who doesn’t follow the proceedings. A normal class lasts 45-60 minutes. Cognitive research indicates that attention wanes dramatically after about 20 minutes, which would indicate that unless the students are allowed some pause for thought, a significant portion of the curriculum is lost on the students during class.

The main objective of the SRS is to address these issues; in particular:

- Break the monotony of a lecture and allow the students to actively take part in the lecture
- Increase teacher-student interaction
- Give both teacher and students “real-time” feedback on learning effect

The SRS consists of two main components: the handheld units, which the students use to submit a response during a voting session; and a server. The server has three main tasks:

- Set up the handheld units prior to the vote by uploading the voting interface to each unit (i.e. buttons “A”, “B”, “C” etc. corresponding to the selected vote type)
- Collect the response from each handheld unit
- Processes the data to create graphical representations of how the students voted

The handheld units use a wireless Internet connection to communicate with the server.

The SRS can be used within a multitude of methodical and educational approaches. Two approaches are of particular interest, both of which have been tested by us:

- Letting the students discuss 2-3 minutes between themselves in groups before doing a voting session
- Peer instruction: each student first has to think individually through the quiz question before casting a vote. Once the vote is cast (and the results of the vote is shown to the students), a group discussion ensues, during which each student has to argue his or her position to the rest of the group. After the group discussion another vote is held, and the results between the two voting sessions can be compared

A typical SRS session runs as follows:

- Handheld units are distributed to the students (preferably before the class starts)
- The students are presented with a multiple-choice quiz question, where only one alternative correct
- The students are given time to discuss between themselves (in the peer instruction paradigm, they are given time to think through the question individually first)
- From a web interface, the teacher starts the voting session (a timer/countdown mechanism can be used, if desired)
- Each student casts a vote as to what the correct answer is, using the handheld unit
- The vote closes and the results are shown to the students in the form of an histogram
- The instructor will comment the various alternatives and highlight the correct one – explaining thoroughly why it’s the correct one; and why the other ones are incorrect
- The lecture proceeds as normal

4 WHY USE RESPONSE SYSTEMS IN CLASS

Multiple-choice questions in combination with use of student response systems may be used to stimulate in-class discussions [6-7] where for instance students may learn from each other. A typical example is peer-instruction based learning processes where the student starts by figuring out a solution them self, and then vote on the alternative they have selected. Afterwards they participate in a discussion where they argue for what they believe is the correct alternative. At the end they vote once more, and the results are shown on the blackboard.

Use of response systems help teachers and instructors to

- Activate the students in order to avoid passive listening
- Improve learning of course content by promoting engagement during a lecture
- Promote a training environment where students collaborate and learn form each other by initiating discussions
- Motivate and encourage every student to participate in class learning activities
• Create a learning and training space where all students may participate anonymously, whereby those students that don’t raise their hands may express their opinions and thoughts
• Check up if students understand what the teacher is teaching during class
• Use teaching methods which adapt and reflect to what students absorb during the lecture
• Improve the storytelling by introducing a small gaming element where each student waits with expectations in order to observe how their classmates answered

5 RESULTS AND DISCUSSION

Using mobile devices or laptop computers, both in the classroom or at distance, trainers can start discussions or introduce evaluation moments to the group of trainees, and get their participation and feedback instantly. The SRS provides new pedagogical methods [8-10] that enhance interactive teaching models by enhancing communication and instructional feedback loops. Collected data is immediately available to the trainer, both in a qualitative and quantitative way, allowing the trainer to understand if the learning outcomes of the trainees are in line with the overall training objectives. SRS mainly supports multiple-choice questions, but teachers can sample extensive data regarding their students' knowledge that is otherwise hard to obtain. Collected data is immediately available to the trainer, both in a qualitative and quantitative way, allowing the trainer to understand if the learning outcomes of the trainees are in line with the overall training objectives. SRS mainly supports multiple-choice questions, but teachers can sample extensive data regarding their students' knowledge that is otherwise hard to obtain.

Based on this information, it’s possible for trainers to make decisions on the fly during the course of the sessions and introduce adjustments to their initial training session plan, aiming the trainee’s full achievement of the learning objectives/competences. Experience on testing this system has shown that this methodology:

• Increases the level of participation of the trainees (close to 100%);
• Significant higher engagement, it become fun to attend courses;
• Results in higher levels of motivation, both for trainees and trainers.
• Reduces the use of “paper” training materials in organizations thus contributing to more “environment friendly organizations”;
• It’s “user-friendly” making it very easy and fast to publish and operate evaluation questionnaires within seconds, and to collect “treated data” immediately;
• Increases flexibility: it’s possible to use it to start discussions and as support tool for group discussion or for evaluation purposes (of on going training evaluation, trainers evaluation, impact of training evaluation, trainees learning outcomes, etc).

The new mobile learning environment, and the product- and process-oriented training model close the traditional gap between VET training and the industrial production process workflow. The methods are generic, whereby they are applicable to European wide manufacturing industry sectors (fabrication industries, VET schools and SME’s). They facilitate an innovative solution for cost- and time effective transfer of industrial production process know-how and technology knowledge to SME at a just-in-time basis.

Based on the feedback we’ve received, it’s critically important for the students that the teacher

• Thoroughly explains what the correct alternative was, and why
• Puts a lot of effort into stimulating the discussion between the students – in some classes, the discussion can be a bit heavy-going unless the teacher aids the process along. This problem is exacerbated if the students don’t know each other very well

The training methods specify training tasks, while the technologies used have to be adapted to the production processes inside the company. In this way the technology and production process available inside the company, become the standard of the training provided to a class. The starting approach is an order from a company that supports and produces a value for the training in form of defining a final, completed product. It starts with placing an order inside the school or class, and ends with the receipt of the agreed product by the customer. The training process can be subdivided into a number of work orders that describe the individual production tasks and activities in detail. It must include a description of the sequences and individual work steps, thus describing how work tasks should be carried out. The learning tasks will have a sequential structure, such that the students can acquire the relevant and required knowledge through their own studies and work. Each learning step
provide the preconditions for the next either it is theory or practice. The system with work orders always prescribes the sequence in which the tasks and exercises are going to be dealt with.

The ABT in combination with use of SRS, are going to be implemented and evaluated in a number of courses in Norway, Romania, Slovakia, Slovenia and Hungary during the period 2010 to 2011. By implementing a strategy for inclusion of practical experience of quality assurance and quality control, it is expected that it is going to stimulate the students, and give them a new practical dimension in their educational framework by use of cases that utilizes problem-based training. This includes mastering specific technologies and manufacturing methods, as well as industrial work processes that are part of the production environment.

ACKNOWLEDGEMENT

This project has been funded with support from the European Commission. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use, which may be made of the information contained therein.

REFERENCES

[1] Project MECCA, online at www.histproject.no
[3] Project DO-IT, online at www.histproject.no
[4] Project EuroPlast, online at www.histproject.no