Active-User-Driven Learning for Improving Safety@Work

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Active-User-Driven Learning for Improving Safety@Work

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***Abstract*—In order to improve the teaching method in courses for the safety at work, we need to review basic learning processes and to introduce a more active learning strategy.**

As a matter of fact, a practical way of learning is more efficient than a purely theoric method.

This paper, after a brief analysis of the learning context, will introduce the active-based model and it will discuss a recent learning process, which characterizes the safety at work in an interactive way. The analysis will show a significant gain in terms of quantitative cost that is very important in several working contexts. Moreover, it will show how retrainings are guaranteed without further costs, in order to provide a constant training: this is important especially in critical working fields.

***Index Terms*—Worker Training; Active Learning; Safety at Work.**

I. Introduction

In this work we aim to introduce a Learning System for Safety at Work to provide a flexible and up-to-date training system for enterprises (see [1]).

Nowadays courses for safety are not designed in order to be efficient at a good level in the sense that training groups are not homogeneous and there are a lot of novel issues arising in modern complex working scenarios.

They often require new skills that could be very hard to reach by following existing laboratory practices.

In a more adequate learning model the skill certification must be done by an external user, who doesn't belong to provider teaching group and hence different from teacher and training provider.

It is important to note that provider must know in advance the overall learning process and its objectives. Henceforth the provider role must be kept into account since the requirement phase.

Based on these questions a new approach must be designed to overcome the arising difficulties. In any case the resulting approach must consider first a preliminary set of constraints related to the type of learning scheme and then provide an adequate learning model able to keep into account the emerging active roles from the involved people.

Before entering the details of the methodology we recall the main definitions used in the context of our work.

About the Context we have the following definitions.

- (Trainer) a person, featured in the teaching staff, with communicative skills and capabilities to convey the learners the know-how by training them and giving them not only a theoretical but also a practical modeling.
- (Provider) People who deal with the training course by providing trainers/instructors, on the indications of the training project elaborated by the Organization.
- (Examiner) A person who conducts assessment examinations to students after a training course conducted by a generic teacher.
- (Tutor) A consultant who provides assistance and expertise to an active user.
- (Intermediary) An entity that connects companies with providers/trainers.
- (Interprofessional Organization)] A funding entity that provides financial resources.
- (Company) A company that has to form its subordinates.
- (Active user) active user is a subordinate to the company, with specific experience in their field, with communicative skills as instructor, usually supervised by a tutor. The active user will have the task of gathering the information useful for designing specific training programs.
- (Worker) subordinate worker that must be skilled by newly or update course.

In addition, in the proposed methodology we adopt the following concepts.

- (DIGI.SAFE) Digital Safety Qualifications & Skills system, digital qualification and monitoring system based on web technology.
- (Continuining Professional Development or CPD) It refers to the process of tracking and documenting the skills, knowledge and experience that you gain both formally and informally as you work, beyond any initial training. It's a record of what you experience, learn and then apply.
- (Safety qualifications) A set of qualifications of the work safety skills owned by the physical entity or people.
- (Personal Operative Skills) A set of professional skills from the physical subject.
- (Safety Qualification Card) personal Competences ID

to access the Register of and Qualifications held on DIGI.SAFE.

An efficient training model involves a tailor-made training project based on the needs of the companies. Nevertheless, the current training process does not take into account such an incisive model, in which to the same job corresponds the same risk. This kind of approach is the so-called ”homogeneous groups”, without taking into account the real context in which this task is carried out. (For example, in the construction industry, the same worker who paints a wall with the same equipment in a home or close to the main road has very different risks, but the paint work is called “homogeneous group”). This ”homogeneity” approach can only be compared to a work-sector, for its intrinsic definition ideal for teaching in a school room, but it is very far from the real life in which this job will be applied. This requirement is related to the property assessment of the specific set that we consider below. The testing of the skills should be carried out by an external reference validation, without being self-referenced, outside the provider training center and surely will be not the same trainer teacher which usually has direct connections with the end user of the course, companies and worker, because usually the trainer is paid direct from a company, with evident incompatibility. In addition, the provider should know in detail the training process which are taught, the context in which the job activity are achieved and he will participate in the activities of the “tailor-made” company training project.

With respect to learning requirements, the following constraints needs to be satisfied:

1) (Effective Content Communication) Risk management contents must be communicated in an effective way to students with a clear learning method.
2) (Certificate Promotion) When training level is guaranteed by an external reference validation without implicit self-referenced courses.
3) (Consistency learning program) When the course program will be tuned for selected working applicative area
4) (Homogeneous learning program) Which implies that student class is defined in an homogeneous way (i.e. all people have the same role in the enterprise)
5) (Front-end lessons) It must be required in all cases in which it occurs practical training.

With respect to the above constraints we can distinguish different learning output levels.

1) (**Total efficient learning level**) When all constraints are satisfied.
2) (**Strong efficient learning level**) When only constraint 4 is not satisfied.
3) (**Weak efficient learning level**) When at least constraint 2 is not satisfied.
4) (**Inefficient learning level**) When constraints 2,3 and 4 are not satisfied
5) (**Wrong learning System**) in all other cases.

The Figure 1 shows the Property diagram corresponding to safety at work issues.

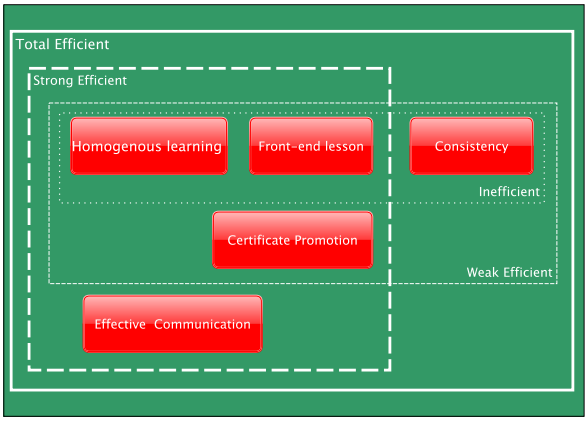

Fig. 1. Learning Efficiency Property Diagram

In [3] it has been published a paper about the benefits for business, not only does poor safety and health cost companies money, but good OSH pays dividends. Businesses with higher safety and health standards are more successful and more sustainable. Studies estimate that for every euro invested in OSH, there is a return of 2.2 euros and that the cost–benefit ratio of improving safety and health is positive. The economic advantages of good OSH are significant both for small business and large ones. One example is the German butchery sector. Participating companies had their premiums reduced if they promoted safety, for example by buying safety knives or giving safety training to drivers. The resulting working scheme is characterized by:

- 1000 fewer re-portable accidents per year for the sector in Germany
- A reduction in costs valued at 40 million euros in six years
- A saving of 4.81 euros for every euro invested

A. *State of Art*

In Italy the national projects cannot be applied to enterprise safety courses due to intrinsic inefficiencies. This is particular true for all cases in which local contexts are quite different from the national legislation.

The projects proposed by legislation can not be brutally applied to companies. Although they provide a minimum level of safety, they become easily inefficient. In the absence of a tailor made model, companies will not have benefit, and obviously their workers. Furthermore, in the current state of art, in Italy Cost/Benefit flow in the training process is summarized by the Diagram shown in Figure 2: The ratio between the costs and the benefits obtained has a ”small” value about 0.30. Very low! In addition, there is an important problem that sees the lack of ownership of the specificity of the training action, where the instructor responsible for the implementation of the training usually get know the specific tasks of the workers only when physically has to do the teaching course, this will make dangerously ineffective course. This framework leaves the trainer’s ability the faculty to comply with the property of

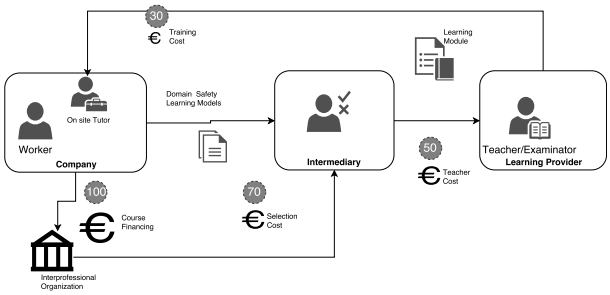

Fig. 2. Cost-Benefit Flow Diagram or Value-Chain BD

specificity, trying to overcome the real working needs of the tasks performed by the learners during or just before began the lessons. We also understand the importance of the front-end lessons, which is a necessary requirement, but if considered only with the required effectiveness, it would still make the inefficient training. Therefore leaving the quality of the course solely to the teacher's capacity is obviously a very risk choice.

B. Related Work

Many training courses in recent years have provided useful data for a general evaluation of the current training activity as outlined in the Overview of the Current Situation.

a) Example 1: For example, a recent upgrade (retraining) course for "forklift carriers" carried out at the chemical production facility of a multinational company, pointed out that training activities were not suited to the actual working context to which operators are called, due to lack of **specificity, homogeneity and rationality** (see figure 1). The course was funded by an "inter-professional fund organization", held by an intermediary company and trained by a provider company by means of a professional trainer.

b) Example 2: Another example of **inefficient** (see figure 1) training was the course for confined space held at an important Italian recycling production company. The course program has completely missed the goal. The workers will get devious knows because they believe that have acquired specific competence without really having them.

c) Example 3: An example of Wrong learning System is given by another course held at a public water management company in a important city of Italy that involved only one teacher and about 80 workers in only two days, in which they dealt with emergency intervention techniques for recovering injured by confined space, where the situation of the provider's training project was completely different from the situation really required by the company to the intermediary.

In this case the presence of crowded course leads to **inefficient** training (see figure 1).

Additionally, there is a lack of PPE (Personal Protective Equipment) thus yielding unsuitable training program.

d) Example 3: Another inefficient training case was held at a regional railway company. The workers asked up descriptions for them jobs leads without any safety elements or wrong equipment into a scheduled generic safety course. In this case the kind of course was not reached, even if the properties have been satisfied.

C. Discussion

From the above examples we can derive that the courses are often wrong because training brokers (training intermediaries) are "hybrids" entities without additional business values. In fact it happens that they are not able/allowed to verify/check the validity of training projects. Therefore, the actual training models do not guarantee any improvement in health and safety at work because:

- poor assessment skills by safety managers
- unable to implement training projects suited to business needs
- inadequacy of equipment and PPEs
- poor lesson schedule organization
- profit-making oriented intermediary in place of quality-making oriented one
- crowded of upgrades training course

From these reasons we introduce a new Learning Model to reduce inefficiencies and optimize organization by considering active learning paradigm called SWIS (Safety Working Interaction System).

II. Safety Working Interaction System (SWIS)

We propose a Learning methodology for Safety@Work which is active based in the sense. It is called Safety Working Interaction System (SWIS) because it assumes a recent paradigm in which the trainers are coordinated in an effective way and under a clear strategy. In particular we assume that the following key issues must be obtained:

1) (training provider) Instructor's learning system which is up-to-date.
2) (training project organization) Tailor-made Learning system plan.
3) (examination board) Examination session with external reviews.
4) (multiple qualification levels) Multiple choices for professionalization.
5) (continuous upgrade) active user instructors are continuously up-to-date

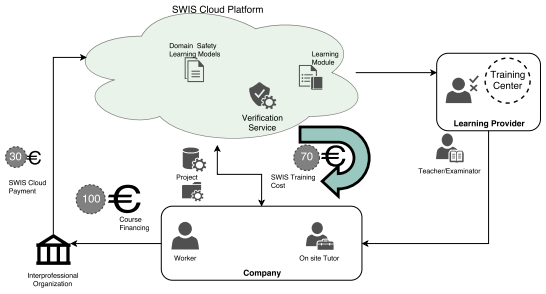

Fig. 3. Cost-Benefit Flow Diagram or Value-Chain BD for SWIS model

The Learning paradigm is described by revising the typical learning phases used in the context of such courses. In the

next section we propose Active based Integration System that includes the main figure necessary in every course, project managers, trainers, tutors, active users. The methodology is dynamic and tailor-made and it is described in Figure 3.

III. Active Based Learning project Phases

We now give the description of step-by-step phases for the Safety Working Interaction System (SWIS) which is proposed by our paper.

1) Consultation phase (assessment) The main SWIS Organization takes observations to understand the company needs. The Company makes a provisional Evaluation. There is a Decalogue of actions that the company will have to perform in order to collect other data, or a draft plan that will evaluate the company, with any cost of training in the project analysis.
2) Project Design Phase (project) The main SWIS organization makes the tailor-made training project for the specific course about the needs of the company's workers. Any business proposals based on their background and depending on the outcome of the consultancy are evaluated.
3) Training phase. After project design the SWIS trainer executes the tailor-made training course in the site company or provider lab.
4) Tutorial phase (active user) SWIS Tutor supports the company active user operators and provides assistance and help to them, because they have not direct skills to lead training. Moreover, Active users are the interface to gather information about the operating conditions. Active users are trained by SWIS tutors and they guarantee the CDP to the company workers.

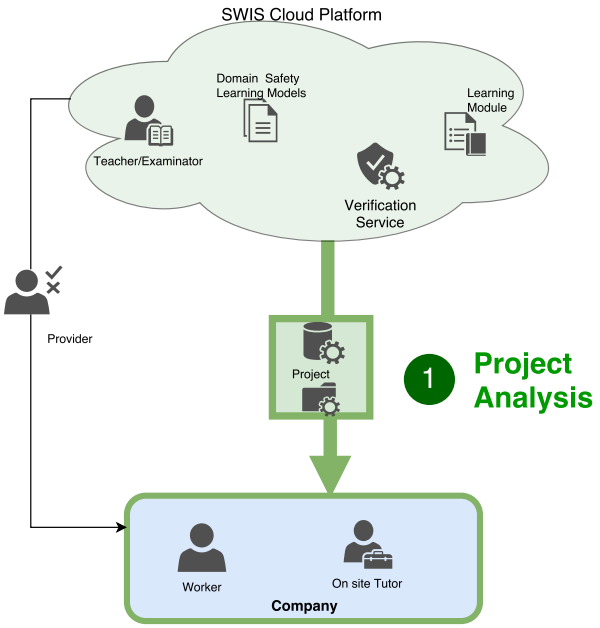

Fig. 4. Phase 1: Company Needs Analysis

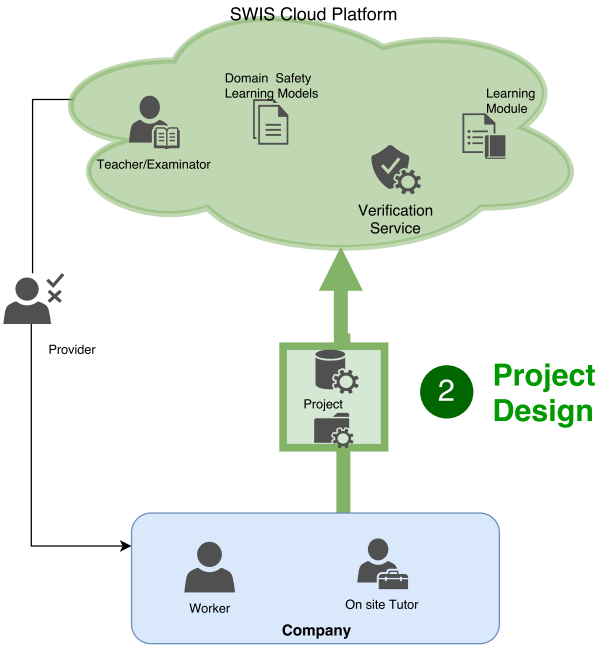

Fig. 5. Phase 2: Learning Project Design and Assignment

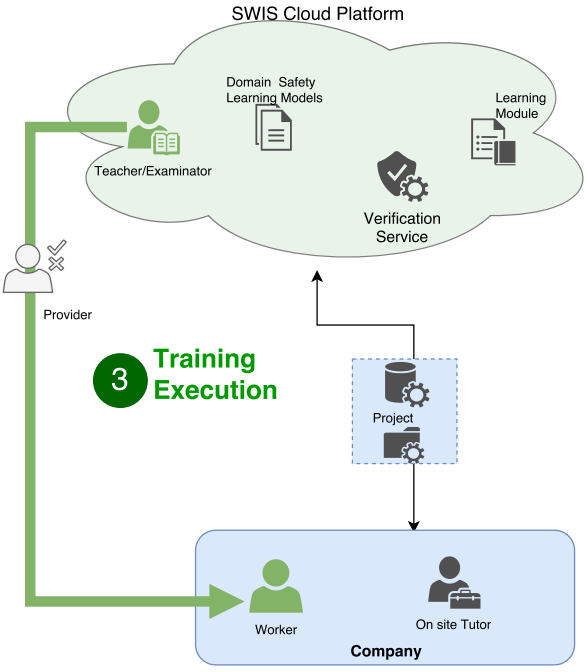

Fig. 6. Phase 3: Training and Test in Safety lab

IV. Cost-Benefit Productivity Analysis

The impact of learning by doing activity in a production system normally could be analyzed in accord to the following cost-benefit function preliminary model ([4]).

If we assume that Q is the quantitative of product, we have that the typical Total Cost function (TC) is defined by:

$$TC(Q) = aQ^2 + bQ \tag{1}$$

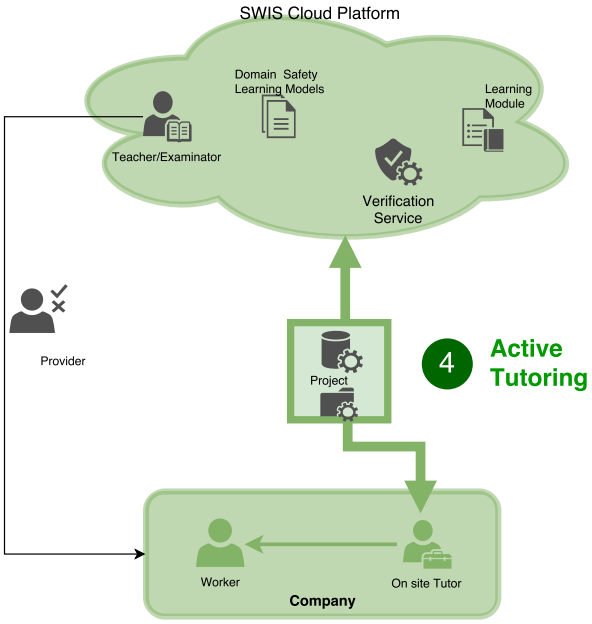

Fig. 7. Phase 4: Active Tutoring for Continuining Professional Development

where a and b are values depending on the company producting factor (see [6]. Put in other form,

$$TC(Q) = (Q - q_0)(x - q_0) + c_m \tag{2}$$

where the constants q_0 and c_m are the values of the quantitative product at minimum cost and maximum possible cost respectively. Note that in general at the same Quantity of Product (Q), the efficiency improves in the sense that the function value decreases, by achieving a lower Average Total Costs per year ($ATCy$) As shown by the Plot 1, we claim to reduce the cost from from the $ATCy_1$ curve to the $ATCy_2$ curve in a given year. Thanks to "learning by doing" process used in the SWI model, we obtain an increase in the stabilization process by accelerating the production. This leads to the second plot (Plot2) in which it has been introduced the third Average Total Cost function per year $ACTy_3$.

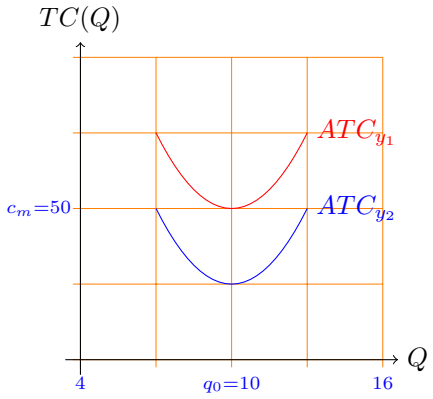

Fig. 8. Plot 1

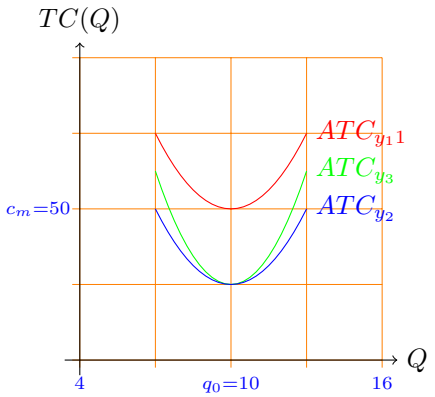

Fig. 9. Plot 2

V. Conclusions

Today, when the typical learning models are applied to health safety at work (HSW [5]), it is not sure that expected learning objectives could be reached in the most working scenarios. The reasons are due mainly to the lack of a tailor made program activity due to the excessive number of intermediaries in the learning cycle process and the small capability to control evaluation learning results also for the lack of certification protocol. Furthermore the overall learning process remains a static process with no continue learning and dynamic adaption to changes. The resulting cost analysis shows a total negative result in terms of improved benefits for new learning courses which are introduced up till now. The cost for each enterprise are growing without any additional improvement in efficiency both for involved enterprise and for intermediate learning provider, thus being in disagreement with European laws on Health Safety at Work ([2]).

In this paper we show a new learning model SWIS with learning feedback on the working field (work based learning) that yields a continuous and dynamic learning process with a tangible evaluation of the safety training level for each worker thus holding a better productivity quantity at increased level of efficiency. It is remarkable that for all societies adopting this model a decrease of working accidents can be obtained in all cases.

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