Online Vocational Training for Safety and Security through Competence- and Work-Based Learning

J. Gracia-Morán[1], J.C. Ruiz, J.C. Baraza-Calvo, D. de Andrés, P.J. Gil-Vicente
Departamento de Informática de Sistemas y Computadores (DISCA),
Universitat Politècnica de València
Valencia, Spain
E-mail: {jgracia, jcruizg, jcbaraza, ddandres, pgil}@disca.upv.es

Conference Key Areas: lifelong learning, continuing engineering education, industry and engineering education

Keywords: vocational training, security and safety, work-based learning

INTRODUCTION

Safety and Security disciplines are related to the degree of trustworthiness that users can place on the exploitation of computer-based systems and services in their everyday tasks. When a failure derived from the occurrence of an accidental fault or an attack occurs, their consequences can be catastrophic, thus leading to unaffordable economical, human or reputation loses to enterprises commercialising or manufacturing such systems. This motivates the industry increasing interest to hire professionals with Safety and Security competences.

Despite their importance, Safety and Security are very shallowly addressed by existing training referential. Undergraduate programs are usually inspired in the curriculum defined by prestigious engineer associations such as IEEE-CS and ACM [1]. Nevertheless, safety is typically a concept more related to human safety than to functional (and thus system-related) safety. However, functional safety is what engineers should guarantee in order to produce and certify critical systems ensuring acceptable levels of human safety. On the other hand, security is considered a horizontal (non-functional) competence and not a discipline by itself. As a result, it is always studied as a desirable feature to obtain from different systems or applications, which lead to a partial, disjoint and disperse introduction of concepts and techniques, thus limiting their scope and usefulness.

Existing master and PhD programs suffer from a similar problem. Even, although with less intensity, certification programs defined by professional bodies. In this way, a single course mixing security and safety concerns is not available. Also, in most of the cases, the training material is declined according to the particular specific technology or methodology under study, rather than the particular competence being worked. In this way, some important questions arise:

[1] Corresponding Author: J. Gracia-Morán, jgracia@disca.upv.es

- Which is the impact of the course in the professional profile of the trainee?
- Which are the new competences acquired?
- Which kind of new activities can be covered with these new competences?
- And last, but not least, to what extend are these set of competences recognized by the professional world and how they fulfil the specific competence legislation of each country?

Vocational training provides an initial answer to the two first questions formulated above. This training differs from the academic undergraduate, MSc or PhD training in the fact that it is further based on experience. So, in such kind of training context, Work-Based Learning (WBL) [2] is preferred. WBL promotes not only the acquisition of knowledge, but also the development of skills and the assimilation of attitudinal patterns that can be exploited in practical work situations. However, the definition of which are the specific competences required from Safety and Security engineers is difficult, since it must take into consideration the actual, and possible future, necessities of Information and Communication Technology (ICT) professionals.

Beyond the development of competences, one should not forget that training professionals implies working with learners with high potential mobility. This exposes two main challenges to any training approach. Firstly, and conversely to what happens when university trainees, professionals can only devote a limited amount of time. And secondly, its prior learning can be quite heterogeneous. As a result, units of content should follow the design of knowledge pills, they should remain available 24/7/365 (so they must be online) and, for each unit, a precise identification and assessment of prior leaning and learning outcomes should be done.

The RISKY project is an online, competence- and WBL-based vocational training approach for Safety and Security professionals [3]. Funded by the Leonardo da Vinci agency[2], it sets a collaborative network to promote experience exchange between Safety and Security trainers, learners, industrial experts and professional associations. Feedback continuously provided by the RISKY Industrial Advisory Board (IAB) helps to tune this training approach. Experience and real cases illustrate concepts that foster the representativeness of the knowledge acquired by learners and promote the development of their competences. The approach supports both asynchronous and synchronous distance learning, which enables the best Safety and Security professionals not only to feed the provided e-learning platform but also to have direct interaction with students using web conference tools.

1 SAFETY AND SECURITY COMPETENCE TRAINING

Despite the particular discipline considered, courses considering either security or safety present a very theoretical orientation, thus forgetting two aspects that are crucial in these competence domains: the human factor and the close relationship existing between safety and security. Relating to the first issue, one should not forget that potential problems must be forecasted and analysed in advance in order to avoid unaffordable system failures. Once the system is in exploitation, if it fails it can be too late to deploy any effective countermeasure. And even, if the engineer can do something, it must react as fast as possible, selecting the most effective available solution for the problem. The other aspect to consider relates to the existing relationship between safety and security. A safety policy must preserve the security of the system and vice versa. This short reflexion shows to what extend experience is

[2] http://ec.europa.eu/education/lifelong-learning-programme/ldv_en.htm

a must in these two domains, and the potential great value of a training approach that exploits the return of experience provided by professionals, in order to develop the competences required from future Safety and Security professionals.

So, and as commented before, Safety and Security competences are rarely found at the same time in today's professional profiles. In this way, Safety and Security engineers must be continuously updating their competences in order to keep pace with technological developments. However, the precise set of competences required for a given professional profile has not been yet defined, as different organisations and entities promote their own qualification according to their particular needs. Professional certifications issued by companies and associations like CISCO Systems[3], ISACA[4] or TÜV Rheinland[5] define a learning path that not only identifies the expected competences to achieve a given expertise level, but also a credited number of years of professional experience. Table 1 summarizes the certifications issued by these entities.

Table 1. Safety and Security certifications according to professional years of experience.

Entity	No Experience	1 year	3 years	5 years	6+ years
CISCO	CCENT	CCNA Security	CCNP Security		CCIE Security CCAr
ISACA			CRISC	CISA CISM	
TÜV			Functional Safety Engineer		Functional Safety Expert

From Table 1, we can see the difficulty to trace a common learning path for Safety and Security professionals, as each entity defines their own expertise levels, as well as their own learning outcomes. Also, these certifications do not provide a competence-based training. For instance, the case studies of ISACA [4] are very generic, and the CISCO courses are very specific, as they are based on their network systems [5].

Trying to solve this problem, the European Union is trying to define a common European framework for ICT professionals in all industry sectors, initiative called European e-Competence Framework[6]. Nevertheless, Safety and Security competences are not joined, and as happened with the educational curriculums, security competences are divided in different European Profiles [6].

Another work specifying the competences for safety-related systems was presented in [7]. In this case, a complete set of safety-related competences is defined, as well as three expertise levels: *Supervised practitioner*, *Practitioner* and *Expert*. Also, it defines a competence model that sets out the relationships between various concepts used when managing competences. It models competences in *Functions, Tasks & Attributes*, in such a way that a *function* is divided in a set of *tasks*, and all tasks in a function are expressed as a set of *attributes*, that is, a set of behavioural skills and underpinning knowledge and understanding.

[3] http://www.cisco.com/web/learning/training-index.html
[4] http://www.isaca.org/CERTIFICATION/Pages/default.aspx
[5] http://www.tuv.com/en/corporate/home.jsp
[6] http://www.ecompetences.eu

2 THE RISKY PROJECT

As commented before, the RISKY project is an online, competence- and WBL-based learning framework for the Security and Safety vocational training of professionals [3]. Led by Scassi[7], the RISKY partners come from different European countries and areas. They are the Universitat Politècnica de València (UPV)[8], Mac Team[9] and NOT Ostrołęka[10]. The main task of RISKY project lies in the establishment of a collaborative network to promote the exchange of experience between trainers, learners and industrial experts. In this way, the final deliverable of the project will be a training process. An Industrial Advisory Board, mainly populated with European industrials coming from the French Aerospace industry and the Spanish Mondragon Corporation, and some professional associations, like ISACA, provides a continuous feedback that helps to tune the training approach, adapting it to the appropriate competences and professional availability. Also, different industrial SMEs are implied in the project, and do contribute to the creation of methodology and course contents, following the slogan *Security and safety training by professionals for professionals*.

Safety and Security courses developed include real-world cases, reducing as much as possible the learning curve slope. The RISKY project is based on an on-line approach, and some in-person classes to reinforce contents. This challenge requires using an e-learning platform and e-conference tools. Assessment of prior learning and learning outcomes is also supported by the RISKY e-learning platform.

Also, the physical mobility of professionals around the world must be taken into account. Such professionals need to obtain an official recognition of their background in each country in order to be able to officially exercise their occupation. When training is oriented towards competences, this is a matter of competence recognition. Thus, agreeing on the learning outcomes issued from his training, competence recognition is a matter of learning outcomes agreement, which is a quite challenging issue. The European Credit for Vocational Education and Training or ECVET is a European attempt to *aim for better compatibility between the different vocational education and training (VET) systems in place across Europe* [8]. As it is done with ECTS[11], qualifications are defined based on learning outcomes. Procedures and rules are necessary for the assessment, transfer, accumulation and recognition of the obtained credits. This feature makes ECVET a very flexible system, as long as ECVET learning outcomes are assessed and validated for transfer credits among different learning paths that can be taken in different countries or different educational contexts. Obviously, national education bodies must certify the entities providing such ECVET, and a supra-national agreement ensuring the fast, or even the *automatic*, recognition of the vocational training credits issued by certified training entities must exist. The advantage is the flexibility of the system. Competences will be built as a sum of knowledge and skill *bricks* which will be obtained in different courses provided in different countries. This provides the opportunity to benefit from the best possible training offered by the best professionals. So, basically competence *bricks* will travel around Europe in the form of ECVETs, thus providing professionals an opportunity to build their profile according to their needs.

This situation leads to the domain of e-learning platforms [9]. Mobility and constraints of professionals makes difficult the provision of courses requiring their presence. The

[7] http://www.scassi.com/
[8] http://www.upv.es/index-en.html
[9] http://www.mac-team.com/
[10] http://www.notostroleka.pl
[11] http://ec.europa.eu/education/lifelong-learning-policy/ects_en.htm

use of e-learning platforms combined with the development of videoconference platforms is opening new opportunities for training. Today, the best professionals can participate in courses despite their physical location, using videoconference systems. Any person anywhere can benefit from their expertise. This synchronous training can be combined with asynchronous activities, whose materials are located in web-based e-learning systems. These types of systems also provide means to carry out distant web-based assessments.

3 RISKY E-LEARNING INFRASTRUCTURE

The UPV offers different e-learning platforms, useful for the RISKY project, through its Lifelong Learning Centre[12]. This service manages the activities and non-formal education projects sponsored by the UPV. Specifically, it helps in the acquisition of credits that includes lifelong learning.

Particularly, the RISKY project currently uses two different platforms. The first one, used to communicate with learners, relies on PoliformaT[13], the UPV instantiation of the Sakai e-learning platform. Such platform, helpful to manage the different courses, provides, among other interesting features chat, discussion forums and facilities to upload and download documents (like exercises or lecture and lab supports). It also promotes the use of web technologies to relate a website to each course and to link to any multimedia material (either external or hosted by the own platform).

The RISKY consortium has also used the Poli[Media][14] UPV facilities to register some promotional videos, like the one in Fig. 1. These videos range from short course introductions to overviews of lectures, as well as short explanation videos detailing a theoretical concept or proposing and solving an exercise. Another useful tool provided by the UPV is PoliConecta (see Fig. 2). This tool allows distant synchronous learning. It is based on Adobe Connect®, and it enables distant experts to provide seminars and distant learners to follow it. Thus, the location is no more a problem since it is not necessary being physically present to follow or teach a course.

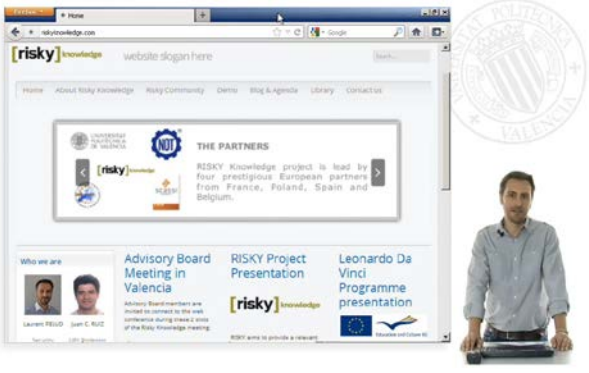

Fig. 1. PoliMedia video presenting the RISKY project[15].

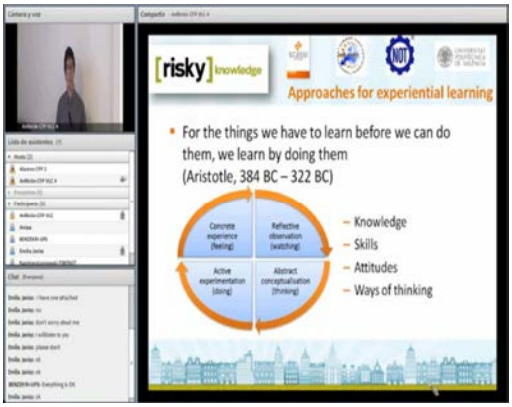

Fig. 2. PoliConecta session within the RISKY project.

At the end of the project, a repository of courses, labs, real case studies and last, but not least, professional testimonies reporting the experience of stakeholders in the domain will be created. This latter innovative aspect will support the WBL- based RISKY approach.

[12] https://www.cfp.upv.es/formacion-permanente/index/index.jsp?idioma=en&menuupv=true&
[13] http://poliformat.upv.es
[14] http://polimedia.blogs.upv.es/?lang=en
[15] https://polimedia.upv.es/visor/?id=e488c19e-869a-904c-8bae-8e08bfb02e74

On the other hand, a new tool is under design in order to automate the creation of courses from requirements, expressed in terms of learning outcomes. The expected learning outcomes will be determined by crossing the learner's prior knowledge assessment with the required competences for a given professional profile and level. All the learning modules, already expressed in the form of learning trees, will thus be analyzed to determine the learning path suited to match the expected learning outcomes of the learner. How to express this information as a software specification and how to automate its exploitation falls out of the purpose of this publication.

For dissemination purposes, the RISKY project relies on its website[16]. All reports and publications carried out by the consortium are publically available in this website, as well as all the information related to RISKY events and partners.

4 RISKY COURSES STRUCTURE

The different courses will be structured in three levels: beginner, intermediate and expert. The three levels follow the WBL methodology. The first step is an assessment of the prior learning of the professional. This assessment is organised in such a way that their results will mark its learning path.

The structure of each one of the three levels is different. Let's start with the beginner level. It is organised in knowledge pills the professional has to study. Each one of the knowledge pills is structured around a script that guides the apprentice through the material. So, learner's first task, when starting a knowledge pill, is to carefully study this script. Then, the trainee can complete their knowledge by using the rest of available material, such as videos, readings, sample cases, etc. The main idea for the beginner level is to provide all necessary material to the professional. After finishing the beginner training, the assessment of the learning outcomes is done.

The structure of the intermediate level is quite different. In this case, the professional will start with a brief review of the beginner level. Then, a simple case study is proposed. The detailed structure is as follows:

- Review of beginner level.
- Simple case study proposal.
- Providing solutions. In this case, the professional must search the necessary information to solve this step. The tutor will guide this search.
- Writing a report (with some minimal contents).
- Assessment of learning outcomes.

Lastly, in the expert level, the professional must evaluate a safety-related architecture. For this level, the detailed structure is as follows:

- Review of intermediate level.
- Proposal of a safety-related architecture.
- Detailed analysis of the safety-related architecture.
- Evaluation of different solutions.
- Writing a report (with some minimal contents).
- Assessment of learning outcomes.

[16] http://www.riskyknowledge.eu

As it can be seen, WBL is intensively used. Also, the learning path a professional must follow is defined by its prior knowledge. For this reason, the prior learning assessment is a critical aspect of this methodology.

5 A SAMPLE CASE STUDY FOLLOWING THE RISKY APPROACH

The methodology proposed in this work was applied during the coordination meeting of the RISKY project held on June 2012 at NOT premises (Polish Federation of Engineering Associations) in Ostrołęka (Poland). In this experience, people from small and medium enterprises adhered to NOT were invited to a half day seminar to make them aware of the importance of safety and security training in their businesses. Finally, 20 professionals attended the seminar.

The first step was to assess the prior learning of the attendees, as required in the proposed approach. This step is of prime importance to correctly focus the aim and scope of next steps. This information, provided by NOT Ostrołęka in our case, reflected that attendees were expected to have a very low level of expertise in the functional safety domain. Accordingly, the rest of the meeting should be tailored to increase their awareness of the need for safety related training. So, using the WBL methodology, a case study was presented. It consisted on a 30 minutes lecture used to increase their awareness in the functional safety domain based on the IEC 61508 standard [10].

After explaining this case study, learning outcomes were assessed. As defined in the proposed approach, this assessment will determine whether the students have achieved the required learning objectives. In our case, the goal of the lecture was just to increase the awareness of attendees towards the functional safety domain. After the seminar, attendees were invited to join a group, which is currently being dynamised by NOT Ostrołęka, to discuss topics related to safety and increase the level of safety awareness of polish small and medium enterprises. As several of the attendees joined the group and have successfully and fruitfully taken part in the different meetings organised by this group, we can conclude that the seminar reached its goal. Accordingly, the approach proposed by the RISKY project may have a promising future as a sound procedure for training professionals in the security and safety domains.

6 SUMMARY AND ACKNOWLEDGMENTS

As it has been shown, the needs of Safety and Security professionals are not addressed correctly. The main problems occur when trying to set in a single approach the needs of enterprises in terms of learning outcomes, with the heterogeneity of learning incomes of professional profiles, and the selection of an adequate learning path for each one of such profiles.

As the assessment of professional competences across Europe is very heterogeneous, the RISKY project uses WBL methodologies, as they are the most suitable for the professional requirements. In order to be useful, results must fit the European VET framework. Since professional bodies are those finally guiding European states towards the acceptance or rejection of approaches to VET, RISKY relies on an international industrial advisory board providing feedback on the adequacy of the produced learning materials for the enterprises and professional associations.

In this way, we have proposed a series of different courses that relies in an effective and European-common assessment of the professional's prior learning. With this assessment, it is possible to establish individual learning paths. Finally, an example

of the application of this methodology is shown. According to the results we have obtained, we can defend its success. In this way, it is not enough having the functional capability to develop a safety critical system, but it is necessary to prove that all the personnel involved in the development have the training, technical knowledge, experience and qualifications required. Thus, it is essential to promote initiatives like the RISKY project to enable professional training in security and safety competences.

Acknowledgements. This work has been funded by the RISKY Leonardo da Vinci project (#2011-1-FR1-LEO05-24482) 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] The Joint Task Force for Computing Curricula 2005, Computing Curricula 2005 - The Overview Report, ACM, AIS & IEEE-CS, http://www.acm.org/education/curric_vols/CC2005-March06Final.pdf, (2006).

[2] Flemming, F.K., Rokkjiaer, O., Schrey, K. (2007), Work Based Learning and Facilitated Work Based Learning, TREE – Teaching and Research in Engineering in Europe, Special Interest Group D8: “Work Based Learning”.

[3] Gracia-Morán, J. et al. (2013), Improving the Transfer of Safety and Security Competences to Industry: the RISKY approach, 14th European Workshop on Dependable Computing (EWDC 2013), Portugal, May 15-16, pp. 185-189.

[4] http://www.isaca.org/Certification/CISA-Certified-Information-Systems-Auditor/Prepare-for-the-Exam/Pages/prepare-for-the-exam.aspx

[5] http://www.cisco.com/web/learning/certifications/professional/ccnp_security/index.html

[6] ftp://ftp.cen.eu/CEN/Sectors/List/ICT/CWAs/CWA%2016458.pdf

[7] The Institution of Engineering and Technology, (2007), Competence Criteria for Safety-Related Systems Practitioners.

[8] Education and Culture DG: The European Credit system for Vocational Education and Training (ECVET). Technical report, European Commission. http://ec.europa.eu/education/lifelong-learning-policy/ecvet en.htm, (2012).

[9] Moore, J.L., Dickson-Deane, C., Galyen, K. (2011), e-Learning, online learning, and distance learning environments: Are they the same?, The Internet and Higher Education, Vol. 14, Issue 2, pp. 129–135.

[10] Technical Committee 65A, System aspects (2010): Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems. Technical Report, International Electrotechnical Commission. http://www.iec.ch/functionalsafety/standards.