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Original article

Content and Language Integrated Learning – functional safety study programme in English

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INFORMATIONS

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ABSTRACT

Safety engineering has become a challenging and rewarding career field in the present day age of rapid technological and scientific advances. But how to raise student's awareness regarding the legal and regulatory requirements introduced by safety organizations and government agencies?

The aim of this paper is to show how successful cooperation between professionals in the field of safety engineering, especially functional safety and experienced university language teachers can boost student motivation and inspire them to face the social and industrial needs of changing business environments.

We will try to prove that a tailor-made course provides students with efficient information about the subject, source material and vocabulary from the field of safety engineering. It will also enable students to use knowledge to respond to hazards and accidents. It will teach them to take independent decisions in emergency situations and prepare them to feel comfortable in the global business.

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KEYWORDS

functional safety, study programme, CLIL

1. Introduction

Current competitive labour market requires various skills from graduates including specialist vocabulary. The ability to live, learn, develop and work in a multi-cultural environment is becoming one of the main factors of our reality. Physical and virtual mobility have great impact on language. This in turn calls for the development of new language to create fusion between content and language.

For years language schools have offered courses at different levels and in different fields. Course participants are usually taught by language teachers whose content knowledge is not advanced enough to teach second-cycle students of Technical Universities. On the other hand, students are expected fluency in the content knowledge of their field of study.

The aim of this paper is to present a process of creating Functional Safety Tailor-Made Study Programme, as a fruitful cooperation between a language teacher and a specialist in the field.

2. Content and Language Integrated Learning (CLIL)

In the 1990s Content and Language Integrated Learning (CLIL) emerged as a new innovative methodology.

'CLIL refers to situations where subjects or parts of subjects, are taught through a foreign language with dual-focussed aims, namely the learning of content, and simultaneous learning of a foreign language' [Mehisto et al. 2008].

'CLIL creates fusion between content and language across subject and encourages independent and co-operative learning, while building common purpose and forums for life long development' [Mehisto et al. 2008].

The suggested study programme is considered from two different points of view. One is discussed from the point of view of a safety engineering specialist responsible for proper contents of the curriculum. The ESP (English for Specific Purposes) teacher focuses on accuracy and ability to communicate effectively on relevant topics in a foreign language, focusing on language quality, language structure and pronunciation. Achieving safety engineering learning outcomes is one of the objectives of the programme.

The didactic process begins long before students start solving assigned tasks.

Experienced teachers and lecturers being familiar with various teaching strategies are able to influence students in such a way that they use their inborn predispositions effectively. Skilled teachers are able to accomplish one of the most difficult and important tasks, boost students motivation.

Thus, the question arises how to build motivation in safety engineering students.

3. Boosting students' motivation

Rapid technological and scientific advances promote safety engineering as a challenging and rewarding career field.

The role of a content teacher is to underline the possibilities of applying the acquired knowledge and skills in prospective jobs.

The more relevant the topic is to students the more motivated they are to learn the content.

CLIL enables students to focus on their interests, exchange opinions, communicate about the content, which leads to the development of language skills.

The following actions are examples of how to increase students' motivation:

- reading technical documentation in a given area to identify acronyms and formulas properly and to comprehend sector-specific texts and standards in English,
- participating in international panel discussions devoted to industrial safety, functional safety, etc.,
- participating in risk analysis international study group,
- participating in discussion groups, groups which bring various professions together,
- obtaining Polish and international certificates of professional competence as a passport to an international career,
- organizing meetings with students who use CLIL language during their vocational training,
- receiving prospective employers in class.

It was observed that students who are motivated to learn the content are motivated to learn the language. However, it is not only students' motivation that is essential in the teaching-learning process. The cooperation between an enthusiastic specialist in the field and a passionate language teacher will guarantee the success [Hattie 2015; Mehisto et al. 2008]. Skills exchange between a language teacher and content teacher requires time and devotion, but it will result in the product which students will benefit from.

4. Programme content – source materials

The programme includes the legal, engineering and management aspects of the functional safety.

The following topics are discussed:

- risk analysis in industrial installations,
- process diagnosis,
- determination of required safety integrity level (SIL) in process industry,
- layer of protection analysis,
- human reliability analysis,

as well as introductory problems like: structure of control system, block diagrams, Boolean algebra, logic gates, to name just a few.

It is assumed that students are familiar with the basis of functional safety, which are taught in the frame of the curriculum.

Students need guidance and support in using source material such as books, standards, technical documentation, list of safety acronyms, web pages, blogs, discussion groups (Paragraph 34), open forums, etc.

One of the tips for selecting practice-oriented tasks is to look at an exemplary documentation of a plant (Fig. 1).

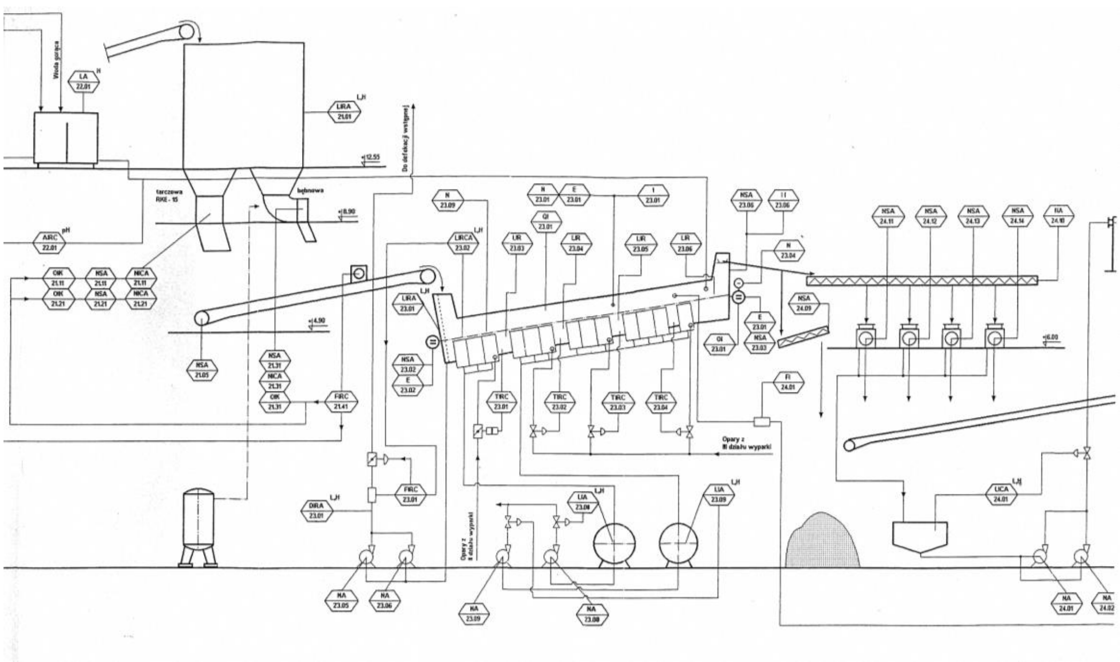

Fig. 1. Exemplary documentation of sugar factory installation

There is no need to analyse the whole system. We cut out one small hexagonal symbol which describes a specific automatic control system. The exemplary system can be described like the one presented in Figure 2.

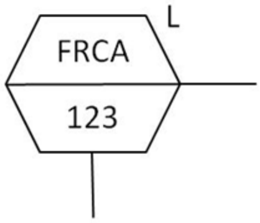

Fig. 2. Exemplary symbol of control system

The first problem students face is the meaning of the word acronym. It is the role of a language teacher to deliver the definition of an acronym.

Acronym BrE//ˈækrənɪm// *noun* a word formed from the first letters of the words that make up the name of something, Oxford Advanced Lerner's Dictionary.

Students are expected to be familiar with the meaning of particular letters.

F stands for Flow;

R stands for Registration;

C stands for Control;

A stands for Alarm;

L stands for Low.

However, they are not always able to form the correct name of the control system.

An English teacher should help them to give the correct name: Flow Control System with the Registration of Flow Quantity with Low Flow Alarm.

Basing on the structure of the system one can, e.g. perform Hazard analysis, qualitative and quantitative risk analysis, determine SIL level and analyse required layers of protection, etc.

The approach to the selected engineering problems concerning functional safety engineering is presented below.

5. The concept of the lesson unit

The crucial problem of the safety analysis is hazard analysis. In general hazard analyses are conducted as follows:

- understanding the analysed system,
- defining the scope and purposes of the analysis,
- selecting the technique of analysis,
- applying the selected method to the system,
- evaluating the results [Borysiewicz et al. 2000; Goble 2010; Gruhn and Cheddie 2006].

During the first meeting students are given materials to prepare presentations in English on typical methods of risk analysis, technical documentation and detailed description of the object to be analysed. The teacher gives general tips of how to prepare a successful presentation in a foreign language underlying the importance of achieving learning outcomes like:

- good understanding of risk analysis methods,
- good understanding of system functioning.

The next stage is a group discussion concerning defining the scope and objectives of the analysis. Then students justify the choice of techniques that will be used to analyse the system. The following step is to apply chosen methods to the system. This part of work should be performed in smaller groups (3-4 students). The final stage is the presentation of the ways of solving a given task and the evaluation of achieved results performed by each group.

All stages are monitored by the teachers, each student gets instant feedback on the applied content knowledge and the accuracy of English language.

6. The example – Fault Tree Analysis (FTA)

The basic aspect of FTA can be explained through an example of a containment spray system which is used to cool the reactor during an accident, described in A.K. Verma et al. [2010].

The scheme of the reactor is shown in Figure 3.

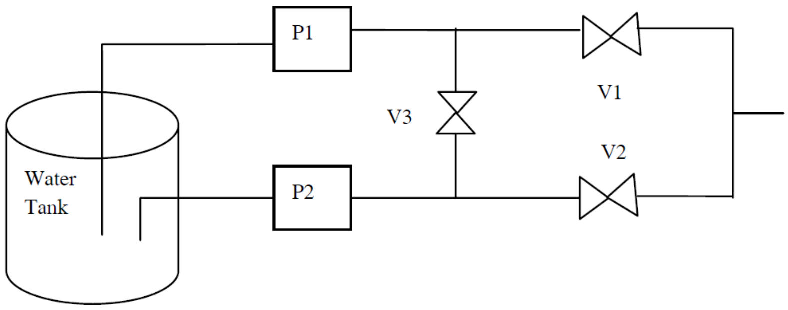

Fig. 3. Containment spray system according to A.K. Verma et al. [2010]
Source: [Nowakowski et al. 2009].

One of the students presents the principle of FTA method using the source materials given during the first meeting and their previous knowledge in the field.

The student's presentation deals with the functioning of the analysed object, which short description is quoted below: 'Any one of the pumps and one of two discharge valves (V_1 and V_2) is sufficient for its successful operation. To improve the reliability, an interconnecting valve (V_3) is there which is normally closed' [Verma et al. 2010].

The teacher makes sure that students have full understanding of the functioning of the cooling system asking them questions or asking them to describe the operation of the system again.

Students define the Top Event, which in this case is 'No water for cooling the reactor'.

Now students are divided into smaller groups and the next task is assigned: Construct a Fault Tree.

Students think of the reasons and come up with their ideas. They discuss potential problems and find real causes. They use appropriate symbols to construct the consecutive level of the fault tree. They follow the same pattern for each step.

Step 1 is to identify possible events leading directly to the Top Event. These events are: No water from V_1 branch and no water from V_2 branch.

These two reasons should be connected by a conjunction gate (Fig. 4).

Step 2 is to define the causes of no water supply through V_1.

Students continue to think of the reasons which, in this case are: No water supply to V_1 or V_1 itself failed. These two reasons could be connected by a disjunction gate.

Step 3. Students deduce the reasons for lack of water supply to V_1 which may be due to simultaneous failure of P_1 branch and V_3 branch. Simultaneous failure of P_1 *and* V_3 require a conjunction gate.

During step 4 the reasons for lack of water supply from V_3 and P_2 are discussed.

Similarly V_2 branch is developed.

This is where students finish Fault Tree construction.

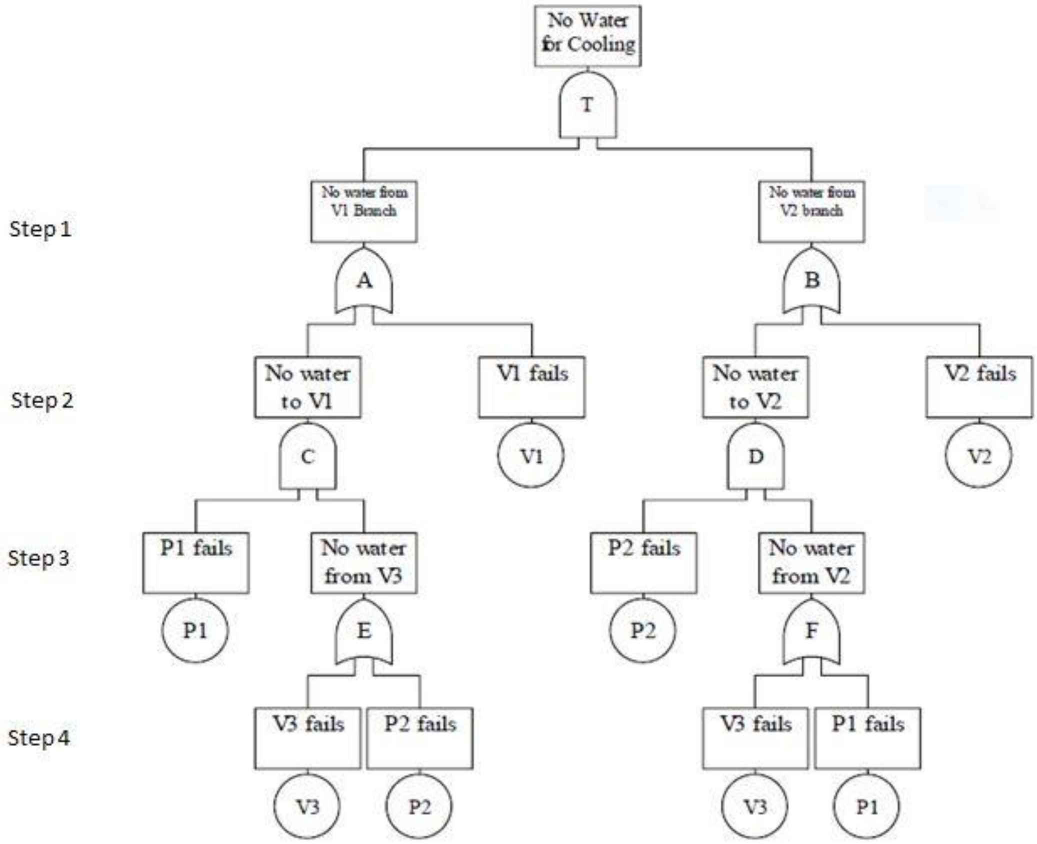

Fig. 4. Fault tree for containment spray system [Verma et al. 2010]
Source: [Nowakowski et al. 2009].

The next task for students is to write the logical relationship between various elements of the Fault Tree which determine minimal cut sets.

This task is followed by the quantitative evaluation which determines the probability value of the Top Event.

These two tasks are assigned as students' homework. The results can be compared and discussed during the next lesson.

7. Discussion

This article shows that there is need for a successful cooperation between a specialist in the field of safety engineering and a language teacher while creating a Functional Safety Study Programme.

CLIL methodology focuses on content, language and learning skills which, when delivered during CLIL lessons, leads to the implementation of the contents related to the field of study described in learning outcomes not related to foreign language teaching.

CLIL approach encourages teachers to leave their comfort zone of the three first stages of Bloom's hierarchy, i.e. knowledge, comprehension and application and move up to the higher stages.

Table 1. Selected learning outcomes of safety engineering curriculum

IB1_U08	is able to identify, model and analyze hazards and risks related to the operation of high risk systems with the use of probabilistic and deterministic methods	T1A_U09 T1A_U13 T1A_U14 T1A_U15
IB1_W11	knows the methods of the description and hazard analysis, risk assessment and the description of the structure of processes	T1A_W04

Source: [Wykaz efektów… 2011].

In the case of the example mentioned above students broaden their knowledge and develop the skills described in the learning outcomes of Safety Engineering Study Programme realised at the University of Life Sciences in Lublin.

They are as follows:

- – a student is able to identify, model and analyze hazards and risks related to the operation of high risk systems with the use of probabilistic and deterministic methods – learning outcome IB1_U08 (Table 1),
- – a student knows the methods of the description and hazard analysis, risk assessment and the description of the structure of processes – learning outcome IB1_W11 (Table 1) [Wykaz efektów… 2011].

Discussing possible events which lead to the Top Event, defining the causes of particular faults, assigning appropriate logical relations to particular reasons, etc., enable students to acquire such skills as analysis, synthesis and evaluation which are related to the higher levels of cognitive domain defined by Bloom (Fig. 5) [Zestawienie materialow… 2012].

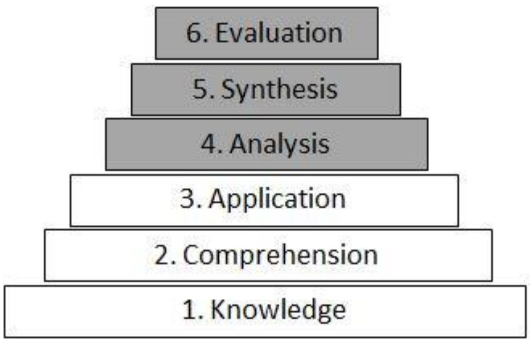

Fig. 5. Hierarchy of cognitive domain (Bloom's taxonomy)
Source: [Zestawienie materialow… 2012]

Conclusions

The presented example of the study programme proves that it is possible to broaden the knowledge and develop the skills in the framework of the subject matter to achieve expected learning outcomes.

CLIL methodology needs to be implemented during planning and delivering a course to help students aim for the highest levels of performance according to Bloom's taxonomy.

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Conflict of interests

The author declared no conflict of interests.

Author contributions

All authors contributed to the interpretation of results and writing of the paper. All authors read and approved the final manuscript.

Ethical statement

The research complies with all national and international ethical requirements.

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