Zeszyty Naukowe Państwowej Wyższej Szkoły Zawodowej im. Witelona w Legnicy
ISSN 1896-8333, e-ISSN 2449-9013 nr 30(1)/2019

Joanna Rączkiewicz
University of Life Sciences in Lublin,
Foreign Languages Teaching Centre
e-mail: joanna.raczkiewicz@up.lublin.pl

Krzysztof Gołacki
University of Life Sciences in Lublin,
Department of Mechanical Engineering and Automatic Control
e-mail: krzysztof.golacki@up.lublin.pl

Application of project-based learning method to create a specialised English course for engineers on the basis of failure modes and effects analysis method

SUMMARY

Globalisation of the labour market conditions the possession of various skills by engineers, which include the knowledge of foreign languages. The unification of technology, technological advances or rapidly developing cross-border trade justify the need for a global language. In the 21st century English has become the lingua franca in international communication. However, limited language skills can constitute a barrier to the transfer of knowledge and skills.

Language teachers and specialists in ESP (English for Specific Purposes) have been trying to find the best method to teach engineers. Content teachers provide great help in assessing the needs of safety and reliability engineers and in selecting authentic materials to be used in class.

This article presents different methods used to teach English to safety and reliability engineers, with the focus on project-based learning as the most effective method to learn the language and acquire relevant skills necessary in an engineering career. Project-based learning is implemented on the example of Failure Modes and Effects Analysis (FMEA) of a reactor cooling system. Before creating the table to document the analysis, learners become acquainted with the system operation; they list all critical components of the system. For each component they describe all the failure modes they are familiar with and discuss which failure modes are important from the point of view of their consequences. During the discussion all the participants express their opinions using words and expressions from the attached glossary. For each component of the failure mode they list the effects on the whole system, the severity of each effect and estimate the criticality of particular failure modes. The final product is an oral or written report prepared by each group.

All the activities performed while solving the problem are characteristic for the project-based learning method. The course is an example of cooperation between an English language teacher and a content teacher.

Key words: project-based learning, specialised English course, FMEA.

Introduction

Over the last few decades we have observed an increasing globalisation of the labour market.

Globalisation is a process in which the people of the world are unified into a single society and function together[1]. More and more social and professional communications, as well as international affairs, call for the demand of a global language. The unification of technology, technological advances, rapidly developing cross-border trade justify the need for a global language.

The economic dominance of English speaking countries, like the USA, puts English at the top as the most frequently spoken foreign languages in non-English speaking countries. However, limited language skills can create a barrier to the transfer of knowledge and skills. Working in multinational companies, employees may feel inferior if their language competence is not as good as their colleagues'. Team performance will suffer, business productivity will decrease. The activity of modern enterprises is based on the cooperation of international teams of engineers who need good understanding of documentation instructions and the functioning of particular equipment. People and machines operate side-by-side in a large number of enterprises, which demands error-free communication, lack of ambiguity concerning maintenance and operating instructions and the consecutive steps in the manufacturing process.

Under the above mentioned conditions functional safety takes on priority status in relation to equipment under control (EUC) and control systems[2]. To survive in a global economy, companies must adopt a global language policy. In the 21st century English has become the lingua franca of international communications[3]. English is a tool to transfer technical knowledge, process knowledge and market knowledge in multicultural teams.

Thus, questions arise: How to overcome language barriers? How to prepare engineers to work in multicultural teams to start an international career? What kind of skills should they have?

English for Specific Purposes (ESP) and Content and Language Integrated Learning (CLIL)

ESP is defined to meet specific needs of the learners[4]. It is an approach focusing on learners' needs and objectives helping them to acquire knowledge of a foreign language and skills that will enable them to function in professional situations. Every target group needs a different approach to learning a language for their occupational needs. Languages for specific purposes are becoming more and more specific; with the increasing demand to teach specialised

---

[1] N. Chomsky, *Chats with Washington Post readers*, „The Washington Post" 2006, March 24, http://www.chomsky.info/debates/20060324.htm.

[2] E. Scharpf, H.W. Thomas, T.R. Stauffer, *Practical SIL TARGET SELECTION Risk Analysis per the IEC 61511 Safety Lifecycle*, USA 2016, s. 1–5.

[3] O.R. Ivan, *Foreign Languages Learning in the Age of Globalisation*, „Quaestus Multidisciplinary Research Journal", Universitatea de Vest Timişoara, http://www.quaestus.ro/en/wp-content/uploads/2012/02/ivan.oana_.pdf

[4] T. St. Dudley-Evans, M. J. John, , *Developments in ESP: A multidisciplinary approach*, Cambridge 1998.

languages to specific recipients, the structure of the taught contents and the methodology have to be carefully determined[5].

Both general language teachers and specialists in ESP have been analysing traditional and alternative teaching approaches to find the best method to teach engineers. However, language teachers qualified to teach foreign languages as a means of communication lack content knowledge. The integrated world imposes the need of an integrated language. In the 1980s the concept of Content and Language Integrated Learning (CLIL) appeared as an umbrella term describing both learning another (content) subject through the medium of a foreign language by studying a content-based subject[6].

CLIL is a strategy that involves teaching and learning of content and language[7]. This fusion between content and language creates great opportunity for the cooperation between content teachers and language teachers aiming at creating specialised English courses that will meet engineers' expectations. Moreover, it is an interactive process in which students are greatly involved in discussing, commenting and exchanging opinions. The role of a teacher changes from a lecturer to an instructor presenting the material and giving instructions for oral and written reports providing language support[8].

Needs analysis

The first step in planning any tailor-made course is to determine the target group and to assess needs analysis. A group of safety and reliability engineers whose prospects are to work in an international team was assessed. Then there was the stage of determining communication needs and language skills they need to increase their competence in risk analysis in English.

The following needs were specified:

- to read technical documentation from the field,
- to correctly identify acronyms and formulas,
- to comprehend sector-specific texts and safety standards in English,
- to participate in international panel discussions devoted to, e.g. labour safety, process safety, control systems, failure modes, causes and consequences of failure, formulating recommendations about the investigated system,
- to obtain Polish and international certificates of professional competence,
- to take part in discussion forums.

The course is designed to build up learners' skills to communicate in English about real-world problems. The materials used in the learning/teaching process should be carefully selected by professionals in the area, and communications that take place in the classroom must simulate the potential communication in the workplace[9].

---

[5] *O nauczaniu i uczeniu się języka obcego dla potrzeb zawodowych*, red. S. Piotrowski, Lublin 2011, s. 61–67.

[6] www.teachingenglish.org.uk, dostęp: 20.02.2018.

[7] P. Mehisto, D. Marsh, M. J. Frigols, *Uncovering CLIL Content and Language Integrated Learning in Bilingual and Multilingual Education*, Macmillan, Oxford 2008, s. 10–11.

[8] Ibidem.

[9] J.C. Richards, *Postscript: the ideology of TESOL* [w:] *The Cambridge guide to teaching English to speakers of other languages*, red. R. Carter, D. Nunan, Cambridge University Press 2001;

Source materials

Source materials used in designing a specialised English course based on risk analysis methods for engineers include:

- sector-specific articles,
- description of production technology,
- process and instrumentation diagrams (P&ID),
- technical documentation of particular apparatus and machines,
- list of possible failure modes,
- record of causes and consequences of critical failure,
- list of definitions and acronyms used in related standards: PN-EN 61508, PN-EN 61511, e.g., SIL, EUC, MooN[10],
- professional blogs.

Teaching specialised language is a learner-centred approach based on learners' needs and purposes for acquiring language skills. It provides a suitable platform for using authentic materials which will be needed during learners' professional career. What is more, authentic materials are proven to increase motivation[11]. Learners gain knowledge they need to solve problems in their professional life.

Choosing the most appropriate method

Most educators teaching engineering and science choose the most traditional deductive approach, which provides theoretical and technical knowledge introduced while lecturing on particular topics. Teachers give instructions which learners follow to solve tasks in class, then they apply the same rules doing their homework and revising for their tests and examinations. Teacher-centred education mentioned above does not teach the skills required from engineers nowadays. During their education learners should be exposed to real-world problems, they should be able to explain why something is happening or has happened applying the knowledge they have. Learners choose the best method to gather information, organise work and study, analyse the data, work in teams, discuss problems and make decisions.

Learner-centred inductive methods are an alternative to the traditional deductive approach. Several inductive methods like: inquiry learning, problem-based learning, project-based learning, case-based learning, discovery learning and just-in-time learning were analysed prior to designing the course. All of the mentioned inductive methods engage students in the learning process by involving them in discussing questions and solving problems while working in groups in or out of class.

M. H. Songhori, *Introduction to Needs Analysis*, „English for Specific Purposes World" 2008, Issue 4, www.esp-world.info.

[10] PN-EN 61508: 2010, Bezpieczeństwo funkcjonalne elektrycznych/elektronicznych/programowanych elektronicznych systemów związanych z bezpieczeństwem – wersja angielska; PN-EN 61511: 2017, Bezpieczeństwo funkcjonalne. Przyrządowe systemy bezpieczeństwa dla sektora przemysłu procesowego – wersja angielska.

[11] Z. Z. V. Baghban, *A Review on the Effectiveness of Using Authentic Materials in ESP Courses*, „English for Specific Purposes World" 2011, Issue 31 Volume 10.

Inquiry learning starts with questions that are required to be answered as well as problems to be solved. When learners face problems they do not comprehend, they ask further questions, observe and apply new information to find the solution. Teachers act as facilitators guiding students to their own conclusions.

In problem-based learning students learn through engagement in the real-world. They use course content and methods to deal with ill-structured problems. Instructors guide students rather than provide them with information.

Project-based learning is an approach directed to knowledge application. Learner teams are assigned a task to solve. The assignment is a real problem or a case study taken directly from the trainees' workplace. They tackle problems to reach solutions and rethink their approach under changing circumstances. The outcome is usually a written or oral report justifying their choices.

Case-based teaching is based on the analysis of case studies of historical or hypothetical situations. Cases should be authentic, complex situations enabling students to acquire decision-making skills, understanding of professional or ethical responsibility and knowledge of current solutions.

The main principle of discovery learning is the student's autonomy during the process of answering a given question or solving a problem. Teachers do not guide students; they set the problem and give feedback on students' attempts to discover most of the things themselves.

Just-in-time learning combines teaching in class with interactive teaching, where students are assigned particular tasks online just before the lecture. Students are encouraged to prepare for class regularly, helping teachers to adjust the lesson plan to the particular needs of students.

In the discussed methods the instructor creates a learning environment by setting a task to solve or a real-world problem to analyse.

Introducing Failure Modes and Effects Analysis method (FMEA) into the course called for an appropriate teaching/learning approach to familiarise students with a new, complex analysis technique. Because of limited number of teaching hours and the fact that course participants were not familiar with FMEA method, project-based learning was selected as the most appropriate method to acquire both technical and non-technical skills by engineering graduates.

A set of instructions have to be defined for students to work on projects assigned by the teacher. Student teams solve problems similar to those they may encounter in their professional lives, applying or integrating knowledge. The final stage of the project is a written or oral report to be presented and discussed in class[12].

Designing course activities

The proposed course is based on the Failure Modes and Effects Analysis method (FMEA). FMEA is a commonly performed analysis technique, which is used in the field of reliability and safety engineering[13]. At the beginning of the course engineers should be provided

---

[12] *O nauczaniu i uczeniu się języka obcego...*, op. cit.; M.J. Prince, R.M. Felder, *Inductive teaching and Learning Methods: Definitions, Comparisons, and Research Bases*, „Journal of Engineering Education" 2006.

[13] W.M. Goble, *Control Systems, Safety Evaluation and Reliability*, International Society of Automation, USA 2010; https://pdfs.semanticscholar.org/presentation/19bc/c4a53cba757dff338953c3ef4437e2ebf052.

with selected authentic texts describing the method taken from standards or books/manuals in English, e.g. IEC 60812[14]. They should become familiar with the advantages of FMEA, with the procedure, with the limitations and the form of documentation of FMEA.

Before they start working on the suggested material, trainees are introduced to the vocabulary indispensable for understanding the principles of the method. Below you will find a list of useful words and phrases.

Tab. 1. List of useful words and phrases used in the example FMEA method

1. Failure modes – rodzaje uszkodzeń	21. Fail shorted – zwarcie
2. Failure – uszkodzenie, awaria	22. Fail open – rozwarcie
3. Reliability (syn. dependability) – niezawodność	23. Drift – upływ
4. In the field of – w obszarze, dziedzinie	24. Stuck at one – zakleszczenie w stanie otwartym (logiczna jedynka)
5. Component – element	25. Contact weld – zespawanie (zgrzanie styków)
6. Level – poziom	26. Ground short – uziemienie (zwarcie z ziemią)
7. Sequence – kolejność	27. RFI – Radio Frequency Interference – zakłócenie częstotliwości radiowej
8. List – wymienić, spisać	28. Comply with standards – przestrzegać norm
9. Severe – poważny, dotkliwy	29. Perceive – postrzegać
10. Severity – dotkliwość	30. Deterioration - pogorszenie
11. Occurrence – występowanie	31. Recurring failures – uporczywe uszkodzenia
12. Detection – wykrycie	32. Noticeable symptoms - widoczne symptomy, oznaki
13. Device – urządzenie	33. Jam open/closed – zacięcie w stanie otwartym/zamkniętym
14. Critical failure – awaria	34. Plugged outlet – zatkany odpływ
15. Design out – usunąć z projektu	35. Electric surge – przebicie
16. Disrupt – zaburzyć, zakłócić, zepsuć	36. False trip – błędne zadziałanie
17. Quantitative – ilościowy	
18. Operational failures – błędy operatora (błędy ludzkie)	
19. Maintenance failures – uszkodzenia podczas konserwacji	
20. Persistence – wytrwałość, cierpliwość	

(authors' elaboration)

Once the learners are acquainted with the technique and have mastered the vocabulary they are presented with a task. The example task is to perform risk analysis of an emergency cooling system of the reactor Fig. 1.

---

pdf.Failure Mode and Effects Analysis based on FMEA 4th Edition, Mark A. Morris ASQ Automotive Division Webinar, 2011, dostęp: 24.06.2018 r.; https://vda-qmc.de/fileadmin/redakteur/Publikationen/FMEA_Harmonisierung/FMEA_Alignment_AIAG_and_VDA_-_ENG.pdf, Alignment of VDA and AIAG FMEA handbooks; Project Leader AIAG: Scott Gray, VDA: Jochen Pfeufer, dostęp: 24.06.2018 r.

[14] IEC 60812: 2006, Analysis techniques for system reliability – Procedure for failure mode and effects analysis (FMEA); W. M. Goble, op. cit.

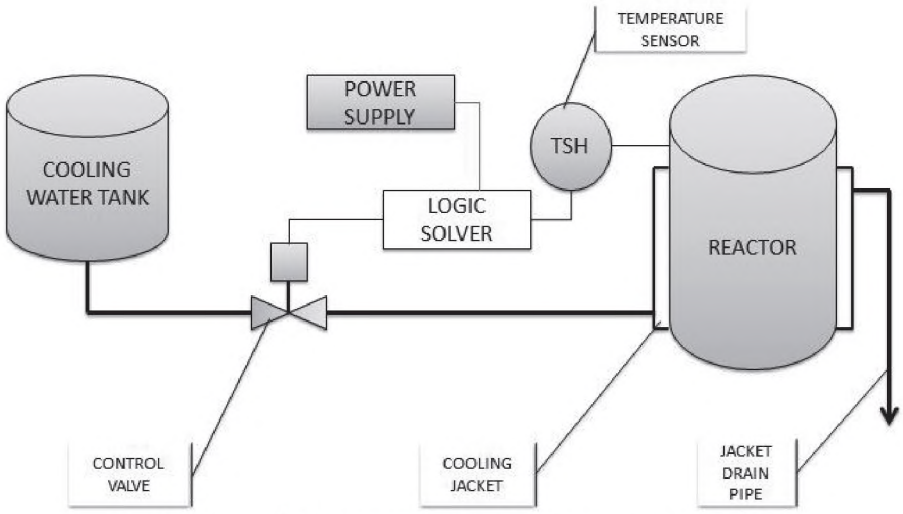

Fig. 1. P&ID of the emergency cooling system of the reactor

The emergency cooling system consists of seven components. They are: a cooling water tank, a control valve, a temperature sensor, a logic solver, a cooling jacket around the reactor and a jacket drain pipe. In normal operation the temperature sensor sends direct signal '1' to the logic solver which keeps the output circuit energised. It means that the electrical current flows from the power supply through the logic solver to the valve and keeps it closed. It is a typical Normally Energised System where for normal operation the temperature in the reactor stays below the dangerous level. If the temperature inside the reactor exceeds the permitted level the temperature sensor sends signal '0' to the logic solver and breaks the input circuit of the logic solver. This stops the flow of electrical current from the power supply through the logic solver, and the valve opens. The water flow cools the reactor lowering the temperature below the dangerous level.

The task for course participants is to perform FMEA for the presented emergency cooling system.

After getting acquainted with the system operation, students list all critical components of the system. Then they create the table to document the whole analysis. For each component they describe all known failure modes and discuss which failure modes are important from the point of view of the consequences[15]. Only the credible failure modes should be taken into account. During the discussion all participants express their own opinions using words and expressions from the attached glossary. For each component failure mode they list the effects on the whole system. The next step is to list the severity of each effect and to estimate the criticality of particular failure modes. All the steps need the discussion based on learners own engineering knowledge and experience, the knowledge provided by the instructor and the documentation of the system. The last part of the FMEA format is the last column which includes remarks and recommendations. Participants give suggestions concerning the ways of risk reduction for each failure mode. They apply their professional

[15] W. Pamuła, *Niezawodność i bezpieczeństwo. Wybór zagadnień*, Gliwice 2011, s. 67–78.

knowledge to complete the task. Suggested recommendations should reduce the risk of critical failure and the number of false trips.

Tab. 2 presents the results of the performed FMEA for the emergency cooling system of the reactor prepared by second-cycle students of Environmental Engineering in the framework of the course: Reliability and Safety of Engineering Systems conducted in English. It is the original students' table with no corrections introduced by the teacher. All the records are the results of the discussion between students working in small groups. The table reveals gaps in students' knowledge and insufficient experience concerning the possible failure modes, mechanics and electronics. To perform the project students were obliged to search for information concerning possible failure modes of particular components of the system. Their task was to discuss three aspects of failure modes: severity of effects (S), the possibility of occurrence (O) and possibility of detection (D). The remarks and recommendations are the summary of the analysis of particular failure modes and result from the knowledge acquired during the analysis of earlier stages of FMEA. All the activities performed while solving the problem are characteristic for project-based learning method.

Apart from skills acquired during a typical language course, learners acquire skills such as analysis, synthesis and evaluation, which are related to higher levels of cognitive domain.

Conclusions

The course is an example of cooperation between a language teacher and a content teacher.

Tailor-made courses designed for students of technical faculties and engineers based on authentic materials are extremely motivating. They expose learners to real problems, which they will or already encounter in their professional lives. Integrated courses prepare students to work in international teams, acquire specialist knowledge which enables them to understand technical documentation in English and to express their opinions and create reports, as well as new technical documentation.

These kinds of courses have to be carefully planned in respect to content, teaching methods and relevance for the position in the enterprise.

Students apply the language and are able to analyse hazards, discuss causes and consequences of failure in English. They acquire self-confidence and skills to work in international teams of engineers.

What is more, learners perform their tasks in class better when they see the cooperation between the language teacher and content teacher. Cooperation between students/co-workers becomes a natural behaviour which can easily be applied in a real professional situation.

Tab. 2. FMEA spread sheet – an example of students' report

1	2	3	4	5	6	7	8	9	10	11	12
Name	**Code**	**Function**	**Mode**	**Cause**	**Effect**	**S**	**O**	**D**	**RPN**	**Criticality**	**Recommendation**
Tank	01	-coolant storage	- leak	- corrosion	- loss of coolant	10	1	1	10	D	-leak detection system with alarm
Valve	02	-opens for coolant	- m. jammed opened	- corrosion	- coolant flows when it shouldn't	7	2	2	28	S	-high quality valve (SIL2)
			- m. jammed closed	- valve failure	- coolant doesn't flow when it should	9	2	3	54	D	-high quality valve (SIL2)
			- circuit short	- mechanical damage -connection of circuit wires	-valve jammed	9	2	5	90	D	-high quality valve (SIL2)
			- circuit open	- components disconnection	- valve opens	(7)0	2	2	28	S	-solid connected wires
Cooling jacket	03	-cools reactor	- leak	- corrosion - mechanical damage	- loss of coolant - no cooling	10	3	2	60	D	-leak detection system with alarm -regular inspection
			- clogged	- contaminated coolant	- non-effective cooling	6	2	5	60	D	-flow sensor -filtered coolant
Cooling jacket drain pipe	04	-delivers coolant from tank to cooling jacket	- leak	- corrosion - mechanical damage	- loss of coolant	10	3	2	60	D	-extra pipe -high quality pipe
			- clogged	- contaminated coolant	- disrupted coolant circulation	8	2	4	64	D	-filtered coolant
			- disconnected	- low quality plug	- disrupted coolant circulation	9	2	1	18	D	-high quality plug -additional plug -extra pipe
Temperature switch-high	05	-opens when temperature in reactor is too high	- short circuit	- low quality components - mechanical damage	- doesn't open valve when it should	9	3	4	108	D	-high quality components -resistance sensor with alarm
			-open circuit	- sensor failure - wires disconnection	- opens valve when it shouldn't	7	3	2	42	S	-high quality TSH
Power supply	06	-provides electrical current to TSH and a valve	- short circuit	- mechanical damage - corrosion	- fire - electrical current flows even if it shouldn't	9	2	2	36	D	-high quality generator and wires -de-energized alarm
			-open circuit	- damaged wires - component disconnection	- no electrical current - TSH opens - valve opens	8	2	1	16	S	-solid components connection -de-energized alarm

S- Severity; O- Occurrence; D- Detection; RPN- Risk Priority Number- criticality; S- Safe; D- Dangerous

Bibliography

Baghban Z.Z.V., *A Review on the Effectiveness of Using Authentic Materials in ESP Courses*, „English for Specific Purposes World" 2011, Issue 31 Volume 10.

Chomsky N., *Chats with Washington Post readers*, „The Washington Post" 2006, March 24, http://www.chomsky.info/debates/20060324.htm.

Dudley-Evans, T, St. John, M.J., *Developments in ESP: A multidisciplinary approach*, Cambridge 1998.

Goble W.M., *Control Systems, Safety Evaluation and Reliability*, International Society of Automation, USA 2010.

IEC 60812: 2006, Analysis techniques for system reliability – Procedure for failure mode and effects analysis (FMEA).

Ivan O.R., *Foreign Languages Learning in the Age of Globalisation*, „Quaestus Multidisciplinary Research Journal, Universitatea de Vest Timişoara", http://www.quaestus.ro/en/wp-content/uploads/2012/02/ivan.oana_.pdf.

Mehisto P., Marsh D., Frigols M.J., *Uncovering CLIL Content and Language Integrated Learning in Bilingual and Multilingual Education*, Macmillan, Oxford 2008, s. 10–11 *O nauczaniu i uczeniu się języka obcego dla potrzeb zawodowych*, red. S. Piotrowski, Lublin 2011, s. 61–67.

O nauczaniu i uczeniu się języka obcego dla potrzeb zawodowych, red. S. Piotrowski, Lublin 2011, s. 61–67.

Pamuła W., *Niezawodność i bezpieczeństwo. Wybór zagadnień*, Gliwice 2011, s. 67–78.

PN-EN 61508: 2010 Bezpieczeństwo funkcjonalne elektrycznych/elektronicznych/programowanych elektronicznych systemów związanych z bezpieczeństwem – wersja angielska.

PN-EN 61511: 2017 Bezpieczeństwo funkcjonalne. Przyrządowe systemy bezpieczeństwa dla sektora przemysłu procesowego – wersja angielska.

Prince M.J., Felder R.M, *Inductive teaching and Learning Methods: Definitions, Comparisons, and Research Bases*, „Journal of Engineering Education" 2006.

Richards J.C., *Postscript: the ideology of TESOL* [in:] *The Cambridge guide to teaching English to speakers of other languages*, (Eds.) R. Carter, D. Nunan, Cambridge University Press 2001.

Scharpf E., Thomas H.W., Stauffer T.R., *Practical SIL TARGET SELECTION Risk Analysis per the IEC 61511 Safety Lifecycle*, USA 2016, s. 1–5.

Songhori M.H., *Introduction to Needs Analysis*, „English for Specific Purposes World" 2008, Issue 4, www.esp-world.info.

www.teachingenglish.org.uk, dostęp: 20.02.2018 r.

https://pdfs.semanticscholar.org/presentation/19bc/c4a53cba757dff338953c3ef4437e2ebf052.pdf, Failure Mode and Effects Analysis based on FMEA 4th Edition, Mark A. Morris ASQ Automotive Division Webinar, 2011, dostęp: 24.06.2018 r.

https://vda-qmc.de/fileadmin/redakteur/Publikationen/FMEA_Harmonisierung/FMEA_Alignment_AIAG_and_VDA_-_ENG.pdf, Alignment of VDA and AIAG FMEA handbooks; Project Leader AIAG: Scott Gray, VDA: Jochen Pfeufer, dostęp: 24.06.2018 r.

STRESZCZENIE

Joanna Rączkiewicz, Krzysztof Gołacki

Zastosowanie metody kształcenia opartego na projektach do tworzenia specjalistycznego kursu języka angielskiego dla inżynierów na bazie analizy przyczyn i dotkliwości skutków awarii (FMEA)

Globalizacja rynku pracy wymaga od inżynierów różnorodnych umiejętności, w tym znajomości języków obcych. Ujednolicanie technologii, postęp technologiczny, szybko rozwijający się handel transgraniczny dowodzą potrzeby wprowadzenie globalnego języka. W XXI wieku to język angielski stał się *lingua franca* w komunikacji międzynarodowej. Jednak ograniczone kompetencje językowe mogą stwarzać przeszkodę w przekazywaniu wiedzy i umiejętności.

Nauczyciele języków obcych i specjaliści w dziedzinie ESP (język angielski dla szczególnych celów) próbują znaleźć najlepszą metodę nauczania inżynierów. Nauczyciele przedmiotu stanowią ogromną pomoc w ocenie potrzeb inżynierów zajmujących się bezpieczeństwem i niezawodnością oraz w wyborze autentycznych materiałów wykorzystywanych w trakcie kursu.

W artykule przedstawiono wybrane metody nauczania angielskiego języka specjalistycznego inżynierów ds. bezpieczeństwa i niezawodności, ze szczególnym uwzględnieniem *project-based learning* (metody kształcenia opartego na projektach), jako najbardziej skutecznego narzędzia do nauki języka i zdobycia umiejętności niezbędnych w karierze inżyniera. W tym przypadku nauczanie oparte na projektach realizowane jest na przykładzie metody FMEA systemu chłodzenia reaktora. Przed utworzeniem tabeli w celu udokumentowania analizy ryzyka, kursanci zapoznają się z działaniem systemu, wymieniają jego krytyczne elementy, dla każdego elementu opisują wszystkie znane tryby uszkodzeń i omawiają, które z nich są ważne z punktu widzenia konsekwencji. Podczas dyskusji uczestnicy kursu wyrażają swoje opinie, wykorzystując słownictwo z załączonego słownika. Dla każdego rodzaju uszkodzenia elementu wymieniają jego wpływ na cały system, dotkliwość każdego skutku i oceniają krytyczność poszczególnych trybów uszkodzeń. Ostatnim etapem jest zaprezentowanie ustnego lub pisemnego raportu przygotowanego przez każdą grupę.

Czynności wykonywane podczas rozwiązywania problemu są charakterystyczne dla metody *project-based learning*. Kurs jest przykładem współpracy pomiędzy nauczycielem języka angielskiego a nauczycielem przedmiotu.

Słowa kluczowe: metoda oparta na projektach, specjalistyczny kurs języka angielskiego, metoda analizy ryzyka – FMEA.

Data wpływu artykułu: 28.02.2018 r.
Data akceptacji artykułu: 12.06.2018 r.