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Повышение иноязычной коммуникативной компетенции студентов технических специальностей посредством преподавания учебных дисциплин на английском языке

Введение. Актуальность темы статьи обусловлена новыми подходами к содержанию и организации профессиональной подготовки бакалавров в свете требований ЮНЕСКО к устойчивому развитию современного инженерного образования. Практика преподавания в инженерном вузе показывает, что обучение специальным дисциплинам на английском языке способствует развитию как профессиональных, так и коммуникативных компетенций глобального инженера. Цель статьи – разработать профессионально-ориентированный модульный учебный курс на английском языке, направленный на развитие иноязычной коммуникативной компетенции бакалавров, и доказать его эффективность в практике обучения.

Материалы и методы. Методологическую основу исследования составили компетентностный и модульный подходы к преподаванию учебных дисциплин на английском языке для русскоговорящих бакалавров по направлению подготовки 14.03.02 «Ядерные физика и технологии». В опытно-экспериментальном исследовании, проведенном на базе Национального исследовательского Томского политехнического университета (РФ), приняли участие 113 студентов бакалавриата 3-4 годов обучения.

Результаты. В рамках исследования был разработан авторский модульный курс на английском языке, который был внедрен в практику четырехлетней подготовки бакалавров, и предлагался обучающимся глубокую и насыщенную языковую практику в рамках тематических модулей, относящихся к областям профессиональной деятельности будущих специалистов, а также регулярное оценивание уровней развития их ИКК на протяжении изучения данного курса.

Полученные результаты свидетельствуют о значительном повышении ИКК испытуемых, в частности, улучшились лексические навыки и навыки устной речи обучающихся. Наиболее яркие результаты продемонстрировали студенты, у которых уровень ИКК на конец обучения оценивался как продвинутый (63,2%).

Заключение. Разработанный и внедренный в учебный процесс англоязычный модульный курс, учитывающий основные принципы компетентностного и модульного подходов, оказал положительное влияние на развитие искового вида компетенции будущих инженеров, что будет способствовать успешному развитию их профессиональной карьеры и становлению как глобальных инженеров.

Ключевые слова: преподавание на английском языке, учебный курс на английском языке, иноязычная коммуникативная компетенция, модуль, устные коммуникативные навыки, профессиональная сфера, ядерные знания и навыки

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Enhancing English as a foreign language communicative competence among engineering undergraduates through English medium instruction

Introduction. The actuality of this research paper is determined by new approaches to the content and organization of professional training for bachelor students in view of UNESCO requirements to sustainable development of modern engineering education. The practical experience gained in the course of teaching in a technical university revealed the fact that English medium instruction contributes to the development of both professional and communicative competences of a global engineer. The current study aims to design a professionally-oriented module-based English medium course targeted at the formation of English as a foreign language competence of non-native bachelors and prove its efficiency in training practice.

Materials and methods. The methodological basis for this study was a competence-based and module-based approaches to teaching academic subjects through English for Russian-speaking bachelor students majoring in nuclear physics and technologies. There were 113 undergraduate students of the 3rd and 4th years of study who took part in the experimental study carried out on the basis of National Research Tomsk Polytechnic University (Russian Federation).

Results. In the course of the research, a module-based English medium course (EMC) was developed and introduced in a four-year bachelor training, which offered trainees deep and rich language practice on a variety of topics referred to their vocational domain and regular assessment of the target competence development throughout the implementation of the target training course.

The obtained results indicated that trainees’ target competence significantly enhanced, in particular, their vocabulary and oral communicative skills. The most striking results were demonstrated by trainees whose levels of the target competence increased significantly and reached advanced level (63.2%).

Conclusion. The EMC course designed in compliance with the main principals of competence-based and module-based approaches had a positive effect on future engineers’ EFL communicative competence development, thus, contributing a lot to their successful career progression as highly professional engineers on the global arena.

Keywords: English medium instruction, English medium course, EFL communicative competence, module, oral communicative skills, vocational domain, nuclear knowledge and skills.

Introduction

Engineering has always played a vital role in creating and maintaining sustainable development of our world aimed at promoting better quality of life for humans through the design and implementation of methods, technologies, devices, tools and instruments. According to 2d UNESCO engineering report [1, p. 20], ‘engineers are now needed to change the world again to help create a smarter world, one that is committed to sustainable development for all, which in turn ‘requires new kinds of engineering and engineers to incorporate the values and objectives of sustainable development into their work’. Following this, a new approach is required to incorporate the so-called ‘values-based engineering into the engineering curriculum of most educational institutions’ [ibid].

Engineering education in the field of nuclear science and technology is an integral component of the state policy in the given domain. Understanding that the nuclear field, comprising industry, government authorities, regulators, R&D organizations and educational institutions, relies heavily on a specialized, highly trained and motivated workforce for its sustainability [2], the national educational institutions are currently implementing a large number of nuclear educational programmes both at bachelor and master levels. All of them are aimed at satisfying the country’s existing and anticipated needs for the well-qualified personnel to develop and maintain the field of nuclear energy use.

The great significance of a good quality training for would-be nuclear specialists can be explained by the following. The nuclear field is now at a mature stage of development, which means the workforce of the twentieth century is now ageing. Hereby, the national nuclear industry enterprises will be recruiting a fresh workforce for the new facilities being planned inside and outside the country. In addition, greater worldwide mobility of nuclear personnel is also expected in the future, making the process of nuclear personnel training more well-designed, sophisticated and globally oriented. It should be noted that globalization has created an increasing need to communicate with others outside of one’s own country [2]. The globalized scientific and industrial community require Russian engineering university graduates to become globally recognized, i.e. to communicate successfully in the international economic, academic, and scientific environment.

In this research, we recognize a global nuclear engineer as a specialist who possesses good and diverse expertise and skills in the field of nuclear energy and is ‘able to collaborate on a global basis, possesses knowledge and/or understanding of people, culture and language, <...> to communicate effectively both orally and in writing in English, and <...> across language and cultural differences’ [3; 4].

The actuality of the conducted research is determined by the genuine interest to the development of a EFL communicative competence among the bachelor graduates in the field 14.03.02 Nuclear physics and technologies. The Federal State Educational Standard of Higher Education as applied to the aforementioned field states that upon completion of the program, graduates shall demonstrate good command of a set of competencies, which include universal competences in addition to professional ones [5, p. 5-6]. One of the universal competences in the area of communication is connected with the ability to perform business communication in its oral and written forms in a state and foreign language. To continue, it is of importance to stress that the International Atomic Energy Agency (IAEA), the international center for cooperation in the nuclear field to promote the safe, secure
and peaceful use of nuclear technologies, developed international recommendations for designing the nuclear engineering education worldwide in accordance with which an intended engineer with a Bachelor’s degree shall possess one of the general competences allowing them to perform written and informal communications and reports in their national language, and possibly English [6, p. 8].

Further, we analyzed the criteria developed by the Association for Engineering Education of Russia (AEER) used to carry out professional accreditation of engineering programmes. One of the criteria is for an engineering graduate to perform effective communication with engineering community and society in national and international contexts; develop documents; present and advocate outputs of complex engineering activity in the appropriate professional area [7, p. 11].

In accordance with the Canadian Engineering Accreditation Board (CEAB), graduating engineers have to demonstrate competency in the twelve main outcome areas, with one of them being communication skills which are defined as ‘an ability to communicate complex engineering concepts within the profession and with society at large’, which includes ‘reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions’ [8]. To proceed, humanities, social sciences, arts, and communications complement the technical content of the engineering curriculum, therefore, oral and written communications are considered to be essential in the education of an engineer [ibid.].

As demonstrated earlier elsewhere [9; 10], the aforementioned trends in the engineering education have significantly strengthened the role and importance of EFL in enhancing the quality of professional training for Russian intended engineers. The graduates are required to use English as a means of intercultural professional communication, allowing them to continue education as well as to do an internship in an international setting, and interact in a variety of spheres, i.e. deal with foreign information resources, write business correspondence, participate in international collaborative research teams, etc. Summing up, mastering EFL is considered an important requirement to reach social, academic and economic growth around the world [11].

Following [12], we agree that it is of significant importance to train engineering graduates to become capable of performing their professional functions and solving professional tasks with the use of EFL following the requirements of national and international educational and professional standards and requirements.

However, we believe that to achieve this aim a small number of limitations need to be taken into consideration and overcome subsequently. The most important of them is that engineering curricula in a large number of Russian technical universities provide for the obligatory learning of the discipline “Foreign language (English)” within the period of one or rarely two academic years. Considering that almost half of first-year students tend to demonstrate the elementary or high-elementary level of EFL proficiency in the entry placement, it becomes clear that the time volume of approximately 72-100 academic hours is insufficient to develop their EFL communicative competence to comply with the aforementioned standards and requirements. Another significant difficulty lies in that the aforementioned discipline is aimed mostly at the development of trainees’ EFL communicative competence in social and academic domains, whereas the professional domain tends to be neglected or paid insufficient attention to.

Thus, there are obvious and significant contradictions between the internationally recognized requirements and recommendations to the nuclear personnel training and the
The current educational system in the field of nuclear energy offered by the national technical universities as applied to the foreign language training.

The aim of the present study is to consider the educational context in which bachelor students in the nuclear field could enhance their EFL training in the professional domain to develop both universal and professional competences at the same time. This could be achieved by introducing the EMI to the professional training of the future specialists in the nuclear field. We believe that this aim could be reached by subsequent solving of the following tasks: 1) to design an EMC so as to stimulate the development of EFL communicative competence in the professional context despite the aforementioned limitations, and 2) to analyze the effect of the EMC on the trainees’ academic performance by revealing levels of their EFL competence development at the end of the course study.

In the context of this research, we applied the module-based approach to the construction of the EMC course, which allowed us to realize the competence-based approach to the graded development of EFL competence as well as problem-based and project-based techniques by offering trainees tasks and assignments to discuss and solve problems, considering cases and carrying out projects targeted at professional domains of would-be engineers in the nuclear field.

**Material and research methods**

In the course of the study, the materials of the following regulatory documents were studied: 1) the Federal State Educational Standard of Higher Education as applied to the field of training 14.03.02 “Nuclear Physics and Technology” (bachelor study); 2) the International Atomic Energy Agency (IAEA) recommendations to design the nuclear engineering education worldwide; 3) the criteria developed by the Association for Engineering Education of Russia (AEER) used to carry out professional accreditation of engineering programmes; 4) the Decree of the Government of the Russian Federation dated June 02, 2014 on the approval of the state program «Development of the nuclear power industry complex» for the period up to 2030; 5) the Decree of the Government of the Russian Federation dated March 29, 2019, which approved the new state program «Scientific and technological development of the Russian Federation».

The methodological basis for this study was a competence-based approach to the professional training of bachelor students in the nuclear field, which ensures the development of the following competencies:

- Universal competence UC-4: ability to carry out business communication in oral and written forms in the state language of the Russian Federation and foreign language(s) - in the category (group) of universal competencies "Communication";
- Universal competence UC-5: ability to perceive the intercultural diversity of society in the socio-historical, ethical and philosophical contexts – in the category (group) of universal competencies "Intercultural interaction" [5].

The main research methods included the analysis of the scientific literature of Russian and foreign scientists on the research problem, the experimental study, comprising summative, training and control stages, carried out on the basis of National Research Tomsk Polytechnic University (TPU).

The conducted research involved 113 bachelor students, including 19 students involved in the experimental study, and was performed in accordance with the author’s study.
programme and teaching materials designed for the bachelor students at the TPU in the field of training 14.03.02 Nuclear physics and technologies, specialization «Nuclear reactors and power facilities».

Methodology

**EFL communicative competence**

Communicative competence was initially defined by D. Hymes in 1972 as ‘the level of language learning that enables language users to convey their messages to others and to understand others’ messages within specific contexts’ [13]. This definition of the target competence clearly indicates the ability of a language user to perform both oral and written communication in a diversity of social contexts outside the classroom.

Based on this, M. Canale and M. Swain in 1980 developed their own model of communicative competence which they understood as the combination of grammatical, sociolinguistic and strategic competences, which acting together enable a language user to form and use accurately and correctly sentences and vocabulary, produce and understand language in different social contexts and achieve communicative goals and enhance the effectiveness of communication [14, p. 28-31].

Considering these specific features of the communicative competence, we understand EFL communicative competence of an engineering graduate as a combination of communication skills, which enable intended engineers to interact with others both orally and in writing in a diversity of settings, including professional contexts, in compliance with national and international educational and professional standards and requirements for continuing education, and/or carrying out professional activity in the context of constantly emerging global labour market.

Levels of EFL communicative competence for engineering students in the TPU have been further developed in the light of the experience gained and included basic, intermediate, advanced and high levels, which can correlate with the Common European Framework of Reference for Languages (CEFR) levels [15] as shown in Table 1 Appendix 1. The sufficient minimum level of the target competence for graduating engineers to be demonstrated during the experimental study was determined as that of intermediate, which corresponds to the CEFR В1.

In the course of the conducted research, we decided to interview some of the TPU’s bachelor students majoring in nuclear physics and technology, participants of this research, to find out what could motivate them mostly in mastering EFL in the university setting. According to the data collected through the interviews, three important tendencies were revealed:

1) many of the participants indicated that learning EFL brings many opportunities to travel and meet new people and cultures (47%);

2) some of the interviewees admitted that knowledge of EFL can enable them to communicate ideas to people of other nationalities and understand them at the same time, read books and watch films in English freely (28%);

3) for others, possession of EFL can boost their professional careers since it makes them capable of studying and/or working in the international environment (25%).

Generally, the trainees revealed rather positive and purpose-oriented attitudes to the study of EFL in the university. We believe that the higher the positive attitude
towards the international community and the need to use English to form part of this community, the more likely the language student is to be willing to communicate in English across a range of situations [2]. Additionally, based on the trainees’ perceptions of EFL application in their educational and professional career, we drew up a list of educational and scientific perspectives, which could be relied on when developing the content, structure, tasks and assignments for the EMC course.

Table 1

<table>
<thead>
<tr>
<th>Educational perspectives</th>
<th>Scientific perspectives</th>
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<tbody>
<tr>
<td>• Performing with a presentation on a topic of professional interest</td>
<td>• Discussion of professional issues with native and/or non-native speakers at a scientific seminar / round table</td>
</tr>
<tr>
<td>• Taking part in a translation competition / professionally oriented Olympiad</td>
<td>• Description of methods and material, research outcomes and their interpretation as part of a research article preparation</td>
</tr>
<tr>
<td>• Study and analysis of scientific and technical information, international experience and expertise on a topic of professional interest to prepare a report / review / presentation, etc.</td>
<td>• Giving an oral report at a scientific and research conference</td>
</tr>
<tr>
<td>• Drawing up design and working technical documentation</td>
<td>• Preparation and submission of application documents for a research scholarship</td>
</tr>
<tr>
<td>• Taking part in an international academic exchange program</td>
<td>• Participation in an internship program in a foreign country</td>
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<tr>
<td>• Enrollment on an international master / PhD program</td>
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The data obtained were used as the basis for the design of the EMC in the nuclear science and technology.

**EMI as the learning environment**

The global spread of English has seen an increase in importance placed not only on English language education throughout the world, but also on education through English [16, p. 4]. This educational trend has been largely driven by the fast-developing internalization of higher education which initially originated in European countries and continued its spread in Asian countries. Russian higher educational institutions in their pursuit of developing and strengthening international competitiveness on the global educational market have recently joined this movement offering both international and national students English medium programmes and courses in various fields of training, particularly in engineering. Thus, EMI has started to be gaining its popularity among Russian engineering universities which consider EMI ‘as a tool for creating opportunities for non-native English learners to achieve success in both educational and workplace environments and join a global academic and workplace community’ [17, p. 1114]. Hereby, we consider EMI as ‘the use of the English language to teach academic subjects in countries or jurisdictions where the first language (L1) of the majority of the population is not English’ [18]. This research presents itself a practically-oriented pedagogical case demonstrating how EMI could be implemented in the Russian engineering university context, namely National Research Tomsk Polytechnic University, to teach academic subjects through English for Russian-speaking bachelor students majoring in nuclear physics and technologies.
One of the important steps on the way to achieve the aim of this research was to develop a module-based EMC and support it with appropriate teaching and learning materials. This training course is studied as part of a four-year bachelor program and is covered in the last four semesters of the bachelor training. It was introduced in the programme syllabus as the academic course which successfully integrated professional content in nuclear physics and technologies and EFL proficiency to make bachelor students capable of performing the following tasks:

- to master and use professional terminology in professional contexts;
- to read and understand English-written sources of information including textbooks, guide books, journal abstracts and articles, conference proceedings materials, and documentation referred to professional domains;
- to listen, perceive and understand English-produced oral performances including lectures, multimedia presentations, reports, video materials related to contexts of professional communication;
- to communicate both orally and in writing with native and non-native users of English on the topics of professional communication using professional terminology in an accurate and adequate manner.

The developed content of the EMC programme was implemented experimentally for the third- and fourth-year bachelor students of TPU in the field of training 14.03.02 Nuclear physics and technologies, specialization «Nuclear reactors and power facilities».

The following procedure was adopted to design and implement the EMC into the academic process, which involved several subsequent stages as demonstrated below.

- Study of good practices, methodical approaches, and recommendations on training nuclear experts.
- Making surveys of learners’ interests and needs.
- Setting learning objectives and determination of the course syllabus.
- Selection and sequencing of thematic content.
- Collection of textual and video materials.
- Processing of selected textual and video materials and drawing up thematic terminology lists.
- Development of exercises, tasks and assignments.
- Design of lesson plans.
- Delivery of classes and assessment procedures.
- Evaluation of the training course efficiency.

To design the structure of the EMC course targeted at improving future engineers’ EFL communicative competence, the module-based learning was chosen, which allowed us to tackle three main objectives:

- to take into account learners’ communicative needs and interests related to mastering professionally-oriented communicative competence at a level which is sufficient to perform efficiently in the intercultural communication;
- to raise undergraduates’ awareness of acquiring self-directed learning skills while studying in EMI;
- to enhance engineering students’ professional knowledge and skills through EMI.

The EMC course was constructed based on the two main principles. Firstly, the content of the training course was focused on the professional topics reflecting areas of expertise referred to the design of nuclear reactors and power facilities. This allowed us to develop
and implement the interdisciplinary integrated approach to the course content organization and study. Secondly, we shared the assumption made by Tudor and cited by Xiuqin Zhang and Katie Head that ‘learning activities will be more relevant if it is the students <…> who decide on the conceptual and linguistic content of these activities’. Relatedly, the language activities and tasks to be practised within the course modules were devised considering engineering students’ needs and perceptions. Studies conducted by the authors showed that involving students ‘in the process of designing their own course <…> helps increase the learners’ sense of responsibility for their learning, heighten their motivation and encourage them to put sustained effort into accomplishing the course objectives’ [19].

**Module-based learning**

The basis for the EMC course design was a module defined as a thematic methodological unit characterized by its specific structure and organization as well as a number of its important characteristics, which include:

- time efficiency which can be interpreted as an effective usage of academic time allocated for studying a fraction of learning material. For instance, learners working with a module are capable to cover the same volume of learning content as in the traditional EFL education, but for a shorter time period due to the efficient distribution of learning material within the module units;
- productivity implies efficient coverage of learning material within the amount of academic time set by the instruction programme. This is achieved by organizing learning material in each module in a form of interdependent structural elements, thus, enabling learners to master communication skills in a professional domain gradually and consequently;
- flexibility suggests that a module structure could be easily changed in case if study conditions are modified, for example, learning aims and objectives could be revisited, or a course duration could be shortened or extended, or learning content could be renewed due to upgrade of scientific knowledge in the target field of professional expertise, etc. All in all, we can assume that a module has to be so much flexible that it could be easily used within a new or modified academic setting, e.g. later or earlier than other modules studied, or any structural element of a module could be extracted and utilized in other modules if required.

Using content from other disciplines in language courses has always been considered as beneficial and highly effective for language education as it allows integrating ‘the learning of language with the learning of some <…> academic subject matter <…> relevant to a particular profession’ [20, p. 137], which in turn necessitates the adoption of content-based learning.

Following the principal ideas of content-based learning, the elaborated EMC course included four modules each covered within one academic semester and grouped in accordance with their focus on specific professional topic, learners’ professional concerns and general contribution of a module to the development of EFL competence among the nuclear students. Thus, the learning content of the module 1 reflects certain areas of communication, which require knowledge of mathematics, physics, and chemistry, which learners have already obtained or revised by the end of the third semester. Whereas, the learning content of modules 2, 3 and 4 is focused on the topics related to academic disciplines, which form the core of engineers’ professional training, e.g. nuclear physics, nuclear fuel cycle technologies, nuclear and radiation safety, nuclear facility equipment, etc.
Below is presented one of the options for the construction of the learning content of the EMC based on the requirements set to the professional training of bachelor students in the nuclear field.

**Module 1. Introduction into atomic and nuclear physics.**
1. Basic concepts of atomic and nuclear physics: matter and its structure, atom, nucleus and its structure, models to atom, orbital, nucleon, nuclear reaction, stability of atoms, radioactivity, ionizing radiation.
2. Nuclear reactor: classifications, applications, design characteristics. Research reactors specific features and applications.

**Module 2. Nuclear reactor materials and nuclear power plant equipment.**
1. Fundamentals of materials science, basic and special properties of materials.

**Module 3. Nuclear and radiation safety.**
1. Nuclear reactor protection and control systems.
2. Nuclear reactor defense in-depth.

**Module 4. Safe management of used nuclear materials and radioactive waste.**
2. Decommissioning of nuclear facilities: aims and objectives, strategies and technologies, cases.

The format of training delivery included 51 academic hours of lectures and 70 academic hours of practical sessions, totally 121 academic hours within 4 academic semesters. Lectures were aimed at introducing the trainees into the learning material related to the selected course topics, whereas the practical sessions focused on the application of students’ knowledge through carrying out practical exercises, tasks and assignments in the English medium. In the course of training, the trainees were offered to work with authentic textual material borrowed both from the open sources of information available in the Interment and specialized guides, and video material demonstrating various aspects of nuclear power engineering. To support sustainability and ensure effectiveness of the training delivery, teaching and learning materials were developed for each of the lectures and practical sessions.

The main forms of oral communication performed by the students in class were chosen as follows:
- Discussion of a problem in pairs / groups;
- Design of a timeline of events;
- Searching for, collecting and organizing information on the researched problem;
• Participation in a colloquium;
• Creative retelling of a studied text;
• Design and performance with an oral report using «reader’s protocol»;
• Design and performance with a multimedia presentation;
• Shooting videos based on the previously learnt material;
• Carrying out and delivery of a project work both in pairs and small groups;
• Audio dubbing of a video film;
• Case study.
The written forms of communication included:
• Taking lecture notes;
• Preparation of textual information for presentation slides;
• Completion of “reader’s protocol”;
• Writing short reviews;
• Preparation of a written part of projects.
As far as listening and reading skills are concerned, they were developed through the use of lecturer’s presentations, audio and video materials available in the Internet and study of textual information provided by the course instructor as well as selected by trainees independently while preparing for projects, reports, presentations, and other course related tasks.
It is noteworthy that helping learners develop their self-study skills is considered as one of the EFL course’s primary goals. The conducted research has proved that the development of EFL communicative competence could be significantly enhanced by a well-organized and thoroughly implemented out of class language instruction in which learners’ independent work is given a priority. There is every possibility to believe that learners can be taught to become autonomous provided that special learning strategies are used which ‘will make them capable of improving their learning by themselves’, as N. S. Lengkanawati puts it [21], and that ‘traditional dominance of the teacher’ should be changed into a situation in which a teacher ‘acts as a supervisor of self-directed learning’ [22]. Kumaravadivelu asserts that helping trainees learn how to learn and equipping them with the means necessary to self-direct and self-monitor their own learning <…> is one way of maximizing their chances for success’ (cited by N. S. Lengkanawati in [21].

Hereby, the learners were provided with specially elaborated tasks and assignments enabling them to practice content-based knowledge and EFL communicative skills required to perform successfully in a variety of professional domains. The examples of the designed assignments are introduced below.

Assignment to the module “Introduction into atomic and nuclear physics”: students work as small groups to search for information related to design and operation of nuclear research reactors, and organize the obtained data in a form of an oral report accompanied by a multimedia presentation which covers the following points: research reactors history and statistics; main types of research reactors; applications of nuclear research reactors; nuclear fuels for nuclear research reactors; role and importance of research reactors for nuclear safety in power reactors. Both the report and presentation are delivered by each group during a practical session.

Assignment to the module “Nuclear reactor materials and nuclear power plant equipment”: students work in pairs to develop a project on the topic “Nuclear power plant (NPP)”. The project outcome is the preparation and delivery of an oral report accompanied with a multimedia presentation. The oral report includes the overview of a selected NPP structure, its main systems and components, including its name, location,
year of establishment, current lifetime, electricity production per year, main characteristics (number of power units, reactor design, coolant loops, circuit system, power capacity, fuel, moderator, reflector, and other associated information).

Assignment to the module “Nuclear and radiation safety”: students work individually to make up a multimedia presentation related to the topic “World famous nuclear or radiological accident”. Choose either a radiological or nuclear accident, study open-source information on the chosen accident and organize the material around the following points: definition of nuclear and radiological accident, main reasons why they may occur, consequences they could lead to, short overview of International Nuclear and Radiological Event Scale (INES), description of a chosen accident: location, date of occurrence, INES level, accident category, consequences, and historical lessons learned.

Assignment to the module “Safe management of used nuclear materials and radioactive waste”: students work in small groups to develop and defend in class a decommissioning project (DP) for a hypothetical nuclear facility (NF): a) nuclear power reactor, b) nuclear research reactor, c) nuclear fuel fabrication plant. The project is presented in a practical session and peer-assessed using by students from other groups. Students should follow the recommended stages of the DP: develop the NF decommissioning objectives, define the DP duration, indicate the proposed decommissioning costs, select and justify the decommissioning strategy, develop the stages of the DP and determine their objectives, select and justify the decommissioning techniques in accordance with the selected decommissioning strategy; determine the sequence of the decommissioning techniques implementation; suggest the possible ways and techniques to manage the radioactive waste generated at a hypothetical NF; consider the recycling options for a particular NF's structures, materials and components, determine the final state of the decommissioned NF.

Research results

The experimental study was conducted to reveal efficiency of the EMC implementation targeted at enhancing the EFL communicative competence among bachelor students specializing in the field of nuclear physics and technologies. Taking into consideration the fact that in 2021 there was only one group of third-year bachelor students with a major in nuclear reactors and power facilities, the experimental study was conducted during two years without the control group usage. It was decided to implement two main tests both in the middle and the end of the experimental study with the aim to reveal and evaluate the levels of the target competence development in four particular areas: vocabulary, reading, listening and speaking. Therefore, both of the tests included four sections to differentiate learners in accordance with their linguistic backgrounds.

The section “Translation” comprised two tasks. At the first stage, each student was provided with a card containing three professional terms in Russian language. The students were requested to translate each term into English. As a next stage, trainees were offered to produce a definition of each term in English. The example of the task is given below:

Translate each term below from Russian into English. Give definitions of each of the terms in English.
1. Спринклерная система охлаждения активной зоны.
2. Импульсный предохранительный клапан.
3. Система впрыска теплоносителя высокого давления.
The section “Reading and rendering” comprised the task aimed at examining students’ skills to read two excerpts from authentic specialized textual material for general understanding: one piece of text was in Russian and another one was in English. The length of each excerpt was selected from 1800 to 2000 characters. At the next stage, each student was requested to render the content of English text in Russian and the Russian text using English language. The primary focus in this section was made on the correct usage of nuclear terms in the context and the ability to generalize the key information in the texts avoiding the secondary one.

The section “Listening and making comments” was targeted at evaluating students’ skills to summarize the texts produced by a groupmate in the previous section in both English and Russian using 3-4 sentences and then add one or two sentences of their own to demonstrate the knowledge of the subject matter.

The section “Answering questions” was targeted at interviewing students based on the list of questions which trainees were provided with prior. Each student received two questions from the training instructor, which had to be answered after the preparation time was over. The answer to each question was limited up to 12-15 sentences and must obligatorily contain topic-related professional terminology. The example of the task is given below:

1. Describe the coolant flow path in pressurized water reactors.
2. Explain what a fixed burnable poison is called and the main functions it performs.

To evaluate efficiency of the experimental study based on the implementation of the EMC in nuclear science and technology, the statistical hypothesis test was employed: Student’s t-test for two independent samples (in the middle and after the experimental study). The calculation was done on the basis of intermediate (test 1) and final test (test 2) results which are presented in Tab. 2.

<table>
<thead>
<tr>
<th>Sections of the test</th>
<th>Test 1</th>
<th>Test 2</th>
<th>T-value criteria</th>
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<tbody>
<tr>
<td>Translation</td>
<td>2.10</td>
<td>2.50</td>
<td>2.093</td>
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<tr>
<td></td>
<td></td>
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<td>p≤0.05</td>
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<td>p≤0.01</td>
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<tr>
<td>Reading and rendering</td>
<td>5.37</td>
<td>6.30</td>
<td>2.093</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>p≤0.05</td>
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</tr>
<tr>
<td>Listening and making comments</td>
<td>2.68</td>
<td>3.32</td>
<td>2.093</td>
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<tr>
<td></td>
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</table>

The received data allowed us to conclude that the majority of students showed very good EFL performance in the final testing compared to the interim testing. The average score achieved by the trainees after the first year of the experimental study included: translation – 2.10, reading and rendering – 5.37, listening and making comments – 2.68, answering questions – 3.11. Hereby, the average scores obtained by the students in all sections of the Test 1 enabled us to evaluate the levels of the EFL communicative competence development.
as mostly intermediate and advanced. Upon completion of the experimental study, the average scores revealed in the course of the conducted analysis indicated significant increase in the target competence development: translation – 2.50, reading and rendering – 6.30, listening and making comments – 3.31, answering questions – 4.05. The overall rate of the Test 1 completion reached 66%, whereas that of the test 2 reached 80.5%, which, in turn, conform with intermediate and advanced levels of the EFL communicative competence development correspondingly.

The most striking results were demonstrated by the trainees whose levels of the target competence increased significantly and reached advanced level (63.2%). Meanwhile, the high level was only indicated by 5 per cent (26.3%) of the learners (Fig. 1).

The obtained results proved the validity of the research hypothesis which was based on the assumption that EFL course designed in compliance with the main principals of module-based learning would have a positive effect on future engineers’ EFL communicative competence development, thus, contributing a lot to their successful career progression as highly professional engineers on the global arena.

**Discussion of results**

Initially, there has been a lot of concern as to whether students could really benefit from learning professional disciplines in English under the guidance of local university instructors. In their work, J.Y. Chang, W. Kim and H. Lee gave a thorough analysis of the studies questioning the pros and cons of the so-called EMC and concluded that there was no certain answer to whether EMCs have positive or negative effect on learners mastering core disciplines in an EFL context. All in all, they found out that students should be thoroughly prepared for EMC in terms of academic language proficiency development. This means a good prior work needs to be done to help learners develop their basic academic skills and avoid possible misunderstanding and language gaps in student-tutor communication [23].
It should be noted that within a period of more than five years this practice has proved to be beneficial since TPU's engineering students receive a two-year academic training in general English to be prepared to converse with their university lecturers via English during the subsequent two years to tackle various engineering tasks and solve problems in professional settings. In other words, they do not study English any longer, they practise previously obtained communication skills in situations, which prepare future specialists to design and implement new engineering technologies, do collaborative research and introduce research outcomes to the global scientific community through publishing articles in English, and give talks at international conferences abroad and many other important things.

As mentioned earlier, one of the research aims was to analyze how engineering students’ EFL communicative competence could be increased via a designed EMC and which effect it could have on the learners’ motivation to acquire and apply EFL proficiency upon completion of the university training. The presented in this research module-based EFL course had a strong positive effect on the enhancement of intended engineers’ EFL communicative competence. The analysis of the research results confirmed our initial assumption that the EMC if appropriately designed and implemented can:

- stimulate engineering students’ interest in learning EFL since the system of practical tutorials and self-study work organized in modules supported by extra-curricular academic and research activities, differed significantly from EFL teaching based on conventional approaches and standards by its developmental dimension;
- make a substantial contribution to the rise of learners’ academic attendance and performance which can be exemplified by their better preparation for practical classes which involved carrying out project work, case studies, participation in colloquia and discussions in the target language.

At the end of the experimental study the mean value in the correct and appropriate usage of nuclear terminology in the professional context increased by 19%. This became possible due to the regular and comprehensive study of professional nuclear terminology in every practical class, which involved 1) familiarization of students with the professional terminology in English prior the study of each module and its submodules 2) translation of the nuclear terminology from English into Russian based on the acquired professional knowledge in academic disciplines in nuclear science and technology 3) practicing correct pronunciation of the English nuclear terms and other associated vocabulary items 4) practicing the application of the nuclear terms in speaking through specially elaborated tasks and assignments 5) demonstration of adequate and correct usage of previously learnt nuclear terminology through oral reports, presentations, projects, etc.

As far as the mean value in speaking is concerned, it raised noticeably (by 22%) by the end of the EMC in nuclear science and technology study. The trainees learnt 1) to produce small and lengthy texts in English, 2) to communicate with groupmates in English through the discussion of professional issues, 3) to prepare and deliver in class multimedia presentations, 4) to comment on the video material related to the professional context, 5) to design and introduce projects based on the development and introduction of new engineering concepts and technologies in the sphere of nuclear energy use, etc. As some of the participants noted, they often relied on their native language knowledge and experience when producing oral performances in class. In this regard we agree with Iman Oraif and Mohammed Alrashed who came to a conclusion that ‘use of learners’ L1 should be limited to the most problematic elements in the syllabus, which the learners find hard to acquire’ [24].
Another important implication of the conducted experimental study refers to the enhancement of the trainees’ listening skills which are recognized as the most challenging communicative skills to be mastered in the English professional context. Training in the development of listening skills was conducted on the basis of lectures delivered once in two weeks, watching short videos available in the Internet and rendering their content in English, pair work techniques which involved interaction of students in English while discussing the content-based issues, and etc.

Conclusion

The revisiting of the EMC targeted at undergraduates majoring in nuclear physics and technology required modernization of its academic content and adoption of a renewed approach. The analysis of educational and professional standards as well as scientific literature allowed us to design the modules of the academic course in accordance with the main professional needs, educational and scientific perspectives of intended nuclear specialists.

The conducted research made it possible to resume that the revisited EMC turned to be effective for the trainees who participated in the course implementation owing to the observance of the following conditions. Firstly, the EMI shall be organized and implemented in strict compliance with the requirements of educational and professional standards and be relevant to trainees’ educational and scientific perspectives. Secondly, the promising technology to achieve this can be determined as module-based learning. The EMC training programme elaborated on the basis of modules shall obligatorily take due account of both structural and functional peculiarities of EFL training in the context of a technical university. Each of the EMC modules shall be designed so that to provide internal and external integrity, consistency, and self-sufficiency of all the elements which form every learning module and the whole module-based course at large. Thirdly, the special system of academic activities needs to be implemented for students to practise EFL communication skills, including participation in projects, which enable trainees to apply knowledge of professional subjects and EFL skills. Finally, the EFL instruction shall be provided with the appropriate teaching aids to satisfy learners’ communicative needs and interests in mastering the target competence, thus, allowing them to communicate across cultures in professional settings.

The current study opens a prospect for projecting different other models of training for non-native engineering students in English medium both in national and international contexts.

REFERENCES


# Levels of EFL communicative competence for TPU’s engineering students

<table>
<thead>
<tr>
<th>Level of EFL communicative competence in the TPU</th>
<th>Level description</th>
<th>CEFR level</th>
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</table>
| Basic                                         | • fairly good skills of reading, listening and speaking, and an adequate sociocultural awareness allow establishing oral and written intercultural communication satisfactorily;  
• poor grammar and vocabulary skills impede a wider and deeper understanding of other people’s thoughts and ideas and are insufficient to communicate those of one’s own to others;  
• ill-developed skills to go beyond standard communicative situations;  
• poorly developed listening comprehension skills in the nuclear context;  
• ill-developed skills to understand textual information in the nuclear-related filed, summarize the perceived information and communicate it to another person;  
• poor knowledge of professional subject in the nuclear field accompanied by inappropriate and incorrect usage of professional terminology, grammatical structures and other lexical means. | Waystage (A2) |
| Intermediate                                  | • skills to more freely communicate both orally and in writing in intercultural settings;  
• fairly well-developed skills to interact with others in a variety of professional situations;  
• fairy developed skills to vary speech behavior in case of undergoing insignificant sociocultural difficulties;  
• fairly developed abilities to use context-based vocabulary items related to the nuclear field;  
• fairly developed skills to understand textual information in the nuclear-related filed, summarize the perceived information and communicate it to another person;  
• fairly developed listening comprehension skills in the nuclear context focusing on general information and omitting details;  
• fairly good knowledge of professional subject in the nuclear field accompanied by frequently inappropriate and incorrect usage of professional terminology, grammatical structures and other lexical means. | Threshold (B1) |
| Advanced                                      | • strong enough motivation and confidence to use communication skills in a diversity of professional domains;  
• well-developed intercultural skills and ability to communicate more effectively in intercultural settings;  
• abilities to use necessary and context-oriented vocabulary items related to the nuclear field;  
• skills to understand the main ideas of the textual material in the nuclear-related filed, summarize the perceived information experiencing small difficulties and deficiencies to communicate it to another person;  
• good listening comprehension skills in the nuclear context focusing on general information and omitting details;  
• good expertise in the nuclear field accompanied by frequently appropriate and correct usage of professional terminology, grammatical structures and other lexical means. | Vantage (B2) |
| High | - ability to perform a variety of communicative tasks effectively, demonstrating leadership skills in intercultural contexts.  
- abilities to actively use a sufficiently large amount of vocabulary items related to the nuclear field;  
- well-developed skills to understand the content of the textual material in the nuclear-related field, summarize the perceived information and communicate it to another person;  
- outstanding knowledge of the professional subject accompanied by the active and appropriate usage of professional terminology in the nuclear field, grammatical structures and other lexical means;  
- ability to comprehend orally information, messages, texts, reports produced by another person and referred to the field of nuclear energy.  
- highly developed skills to produce well-structured, logically sequenced, grammatically correct and straightforward oral speech in professional settings. |

**Effective operational proficiency (C1)**