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"PROFESSIONAL TRAINING IN ENGLISH" - DISCIPLINE FOR MASTER DEGREE STUDENTS OF "DIGITAL TECHNOLOGIES IN POWER ENGINEERING" PROGRAM

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Abstract- In the paper the long - term experience of authors in teaching Russian-speaking and English-speaking students of Power Engineering Department to professional disciplines in English (including at overseas universities) is summarized. The article represents pedagogical tools and techniques for involving students in the active development of written and speaking skills on power engineering topics in general and on digital technologies in power engineering, in particular. The teaching methodology was formed taking into account the modern requirements of employers in power industry, as well as the opinions of students and graduates of previous years.

Keywords: Master's Degree Program, Power Engineering, Digital Technology, Professional Training in English, Teaching Methods, Active Learning Methods.

1. INTRODUCTION

Tomsk Polytechnic University (TPU) is implementing the pilot Master's degree program named "Digital Technologies in Power Engineering", which reflects the needs and challenges in power industry to international cooperation, especially relevant in the context of innovation processes and, in particular, the transition to digitalization. The program curriculum includes the discipline "Professional Training in English". The purpose of this discipline is no doubt, since digital technologies in the energy sector are most intensively developed and implemented in the industry of several English-speaking countries in particular.

In addition, it is well known that more than 90% academic research is published in English. For a modern specialist to be familiar with advanced technologies, it is necessary to be able to work with authentic literature, verbally and non-verbally communicate with foreign colleagues. To further stimulation the interest of students in studying professional disciplines in foreign language, a requirement to Master's degree thesis has been introduced - it must include one chapter in English.

Professional training of power engineering students in English at TPU is provided by specialists in the field of power engineering with high level of English proficiency and extensive experience in teaching. This is an undeniable advantage, since a linguist teacher cannot, for objective reasons, be high-qualified specialist in the subtleties of using special terms or hold the professional discussions. The authors of the report designed a syllabus of the discipline, completed the first edition of textbook, and developed an online course.

When preparing materials for classes, the heterogeneous composition of the audience is taken into account for a number of important indicators:

- different level of English language proficiency of undergraduates, due to both the personal abilities to English, and the different quality of language training. Nowadays some students enter the TPU Master programs from other universities where were not such a great focus in English;
- different levels of training in professional disciplines that is explained not only by the different curriculum and syllabuses of professional disciplines in some universities, but also laboratory equipment and teaching methods;
- different levels of motivation to master professional language competence.

2. CONTENT AND STRUCTURE OF CLASSES

2.1. Classes

When implementing this form of training, the authors have developed and used a fairly extensive arsenal of techniques and tools that allow them to achieve syllabus results in teaching to professional discipline in English for non-native speakers. They are named below, briefly commented on, and in some cases illustrated with examples. The teacher is required to possess, first of all, such modern teaching methods as EMI (English as a Medium of Instruction) [1-3], CLIL (Content and Language Integrated Learning) [4-6].

EMI is the instrument for teaching or studying academic subjects in countries where English is not the state language. This methodology is focused on skills in professional field instead of language. But teacher have to possess extremely high level of English proficiency. In 55 countries EMI is legally applied in schools and universities.

CLIL is subject-language integrated learning. Currently, this is one of the most discussed approaches to teaching in a foreign language. In this method, language is not key point, but only a means of learning another subject. When building classes and choosing materials, tasks should be designed so that students learn new, understandable information by means of English. Studying a language becomes more meaningful, and the motivation to practice it increases. The CLIL method involves simultaneous learning of a language, an academic subject and is aimed more at developing soft skills.

A significant difference between CLIL and EMI is that any foreign (non-native) language can be used when the former is applied. It is most appropriate to use CLIL method in the first years of students ' training at the university, since this method is aimed more at psychological comfort when studying a discipline in a foreign language. Then, in senior courses, when the fear of addressing the audience in a foreign language has already been overcome, the use of the EMI approach is more effective. The teacher must be proficient in these methods and have a sufficient level in English. In TPU all teachers are obliged to pass English certification exam each three years.

Using these methods allows teacher to make classes not only interesting, illustrative at giving new information, but also to achieve the stated syllabus results of undergraduates training.

1. Texts for classes should be mostly authentic, which will help the Master students to understand foreign professional literature, technical parameters of power equipment, reference books, and legal documents. In some situations, it is necessary to pre-process the text-reducing unimportant information, simplifying too complex grammatical structures, bringing a synonymous number of professional terms in case of their diversity. It is extremely important that the text contains graphs, tables, diagrams, and formulas that complement the text information and make it more understandable and memorable. It is most appropriate that when switching to a new topic, the teacher should prepare a short presentation explaining the main professional and terminological aspects, and only then supply students with the authentic materials for independent study for the next class. This will avoid misinterpretation of new terms and improve the effectiveness of training.

2. The classes should use educational and professional videos of well-known manufacturers of power equipment, such as ALSTOM, General Electric, Siemens, and others. This allows not only to expand the professional vocabulary, but also to get acquainted with the modern equipment in developed countries, with trends in improving its performance (increased reliability and safety of operation, high service life, low material consumption, low price, minimal impact to the environment, etc.). In many cases, it is difficult or almost impossible to obtain such knowledge within the framework of research and expertise at energy enterprises.

3. The implementation of class tasks can be both group and individual. The tasks themselves (exercises) may contain the following content:

- a professional video with the attached text task, where some terms and even small sentences were removed - fill in the gaps task (this difficult task is advisable to give in the second half of the educational period);
- a scheme of the electrical connection as a single line diagram of a station or substation borrowed from an authentic text that clearly describes all the equipment and circuit design, for example Figure 1 [7]. This type of task is especially liked by students who have a weak motivation to speak in English. It was noticed that there are no problems with this type of tasks when switching to distance learning (initiated by coronavirus pandemic). It is quite easy to transform this task to oral format – students are given schemes that need to be verbally described. In the case of distance learning, students asked to record an audio file and send it to the teacher for checking;

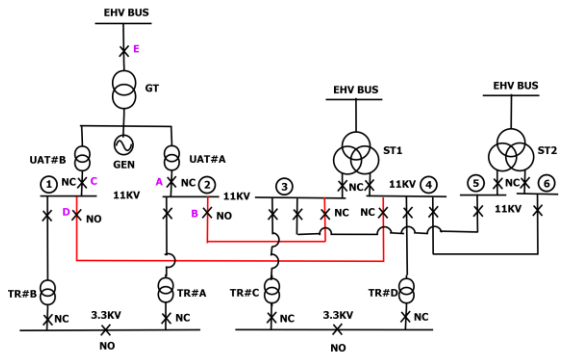

Figure 1. Single line diagram of power plant [7]

- fill in the gaps in the English text with appropriate words and phrases. The gaps are made by teacher according to the level of students special discipline and linguistic proficiency. The use of the logical-creative method in education is possible when sufficient theoretical and terminological knowledge has already been formed;
- translation of special technical terms and specific expressions from English to Russian and from Russian to English with analysis of main mistakes. Analysis has shown that it is much more difficult to translate from native to non-native (English) language;
- analysis and oral description of charts, graphs, tables, equations and schemes. This type of task is successfully used not only to enrich the vocabulary and to practice oral foreign language practice, but in addition make the broad horizons in professional knowledge. This is one of the most successful type of tasks for compelled distance learning in spring 2020 (Table 1, Figure 2, and Figure 3 show examples of such tasks) [8];

Table 1. Estimated time left for fossil fuel

Fossil fuel	Time left
Coal	250 years
Natural gas	70 years
Oil	50 years

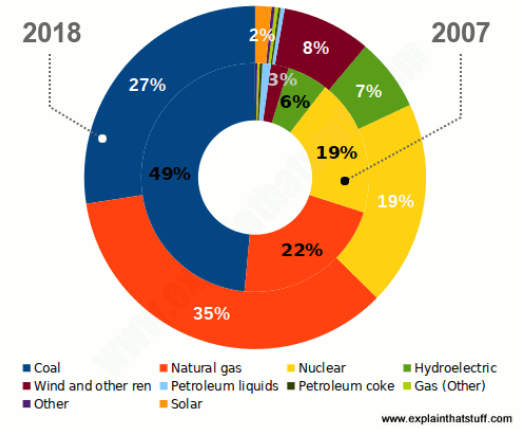

Figure 2. World power generation in 2007 and 2017 [8]

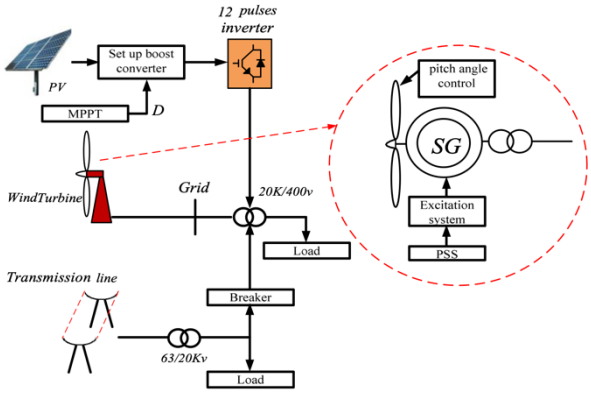

Figure 3. Wind generator and photovoltaic hybrid systems with transmission line [9]

- reconstruction of complex sentences from professional text, previously divided by the teacher into several fragments and arranged randomly. This requires both knowledge of English grammar and professional disciplines;
- team games. For example, students are divided into several groups, they are given the task to briefly present the projects of conventional or non-conventional power plants or substations. There may be one project, but each subgroup represents its own version of the main equipment of the designed power facility. During this type of task, controversial issues may cause transition to scientific discussion;
- quizzes on the topic of classes.

4. Independent work (at home) on texts can include [10]:
- finding of synonyms for terms and their combinations from the text proposed by the teacher;
- answers to questions according to the text;
- the finding out in the English text the phrases equivalent to Russian;
- choosing the true and false statements based on the text;
- writing an annotation of 5-7 sentences to the text using fixed phrases on professional field.

Teacher provides Master's degree students by the authentic materials on professional topics required to complete tasks 4.

5. Group discussion of the main mistakes and misunderstanding of the tasks from number 4, including analysis of main mistakes in translation of scientific papers.

6. Development of project tasks and work on simulators.

As an example, at the ABB-Hitachi simulation [11] the disconnecting-circuit breaker was chosen instead of traditional bulky construction - separate circuit breaker and disconnector. Students may choose different level of voltages and various types of bas bar connection. For individual work the students have to analyze and describe the table of DCB application to substation scheme. The analysis may include not only scheme design, but cost saving, outage and space reduction. Finally, student should make a voice record and send for checking to teacher.

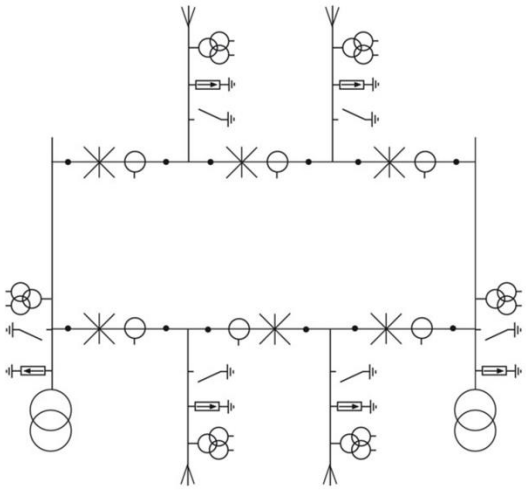

Figure 4. Single line diagram for 420 kV ring bus with DCB [11]

If the development of a simulator requires certain programming skills, then the project-type tasks does not cause much difficulty. For project task, for example, each student must select a switching device from the catalogues of modern manufacturers based on the available input data. Write out the necessary rated parameters, then give the Russian version of the terms. This type of task allows students to use the full range of knowledge - both engineering and linguistic. As a result, not only a clear understanding of the differences in foreign and Russian approach to power plants or substations design is formed, but also a professional dictionary of the most popular terms is formed. An example of a project task is shown in Table 2.

7. Professional discussion of the topic can be prepared in advance by the teacher, or spontaneously arise on the graduate's interests or questions. The latter is preferable, because it is more dynamic, with enhanced motivation of students to take part in it.

Table 2. Disconnector/Isolator

Item (in English)	Unit	Technical data	Russian term
Rated voltage	kV		
Rated current	A		
Rated withstand current (peak value)	kA		
Rated short time withstand current	kA		
Rated duration of short time withstand current	Sec		

8. A relevant objective in the contemporary educational process is implementation of a case study [12-14]. This is justified by:
- the focus of modern education on developing professional competencies, soft and hard skills and abilities, personal qualities, especially abilities to learn and process information,
- changing requirements to employees' qualities, who must be able to rapidly respond to emerging problems, be consistent and effective.

A case-study method is a method of active professional tasks and situations analysis based on learning by addressing specific problems (cases). It is an active imitational teaching method, which can involve role-playing. A case study is a form of continuous assessment, aimed at developing students' skills, personal qualities and acquiring knowledge based on analyzing and solving a problem-based situation with reference to professional activity.

A case study is a verbal description of a problem situation to be discussed and some statistical data that support the study. Students are offered to analyze a real situation, get outside a problem, and suggest options to solve it using current knowledge and extra sources of information. It enables students practicing real-life situations and assuming the role of a decision maker.

To carry out the case study, students are devided into group of 3-4, who are ready to develop original solutions to the problem proposed by the teacher during the semester. At the end of the semester, each group makes a report, which is discussed by students in the class and graded by the teacher.

At the autumn semester 2020 some Master degree students decided to choose Micro Grid analysis for case study. They are especially focused on the most relevant topics of DC transmission of electricity, distributed generation, and Smart Grid. For the last study a hybrid microgrid (Figure. 5.) for residential area power supply with two buses - one bus was standard 10/0.4 kV AC voltage, the second one is DC bus 48-400 V was chosen [15].

2.2. Online Course

To achieve high efficiency of the educational process in online mode, the course should be designed so that, on the one hand, it affords an opportunity to enrich the professional knowledge of students, and on the other hand, it allows to the successful students to expand their knowledge beyond the curriculum.

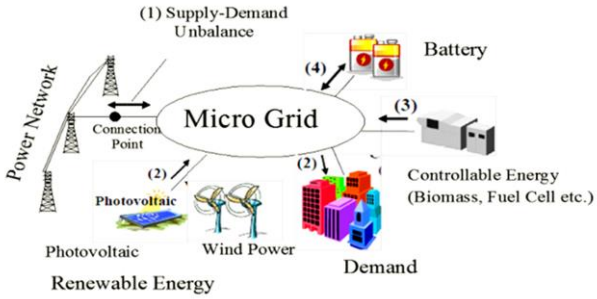

Figure 5. A hybrid microgrid [13]

In our opinion, the online course should include:
- video lectures and their presentations,
- authentic professional handbooks, reference books, and textbooks,
- tests, tasks,
- a dictionary with professional terms and their collocations,
- links to professional literature and scientific articles,
- grammar materials.

The credit work at the end of the semester may be organized in the form of individual presentations (10-15 slides) or an abstract (15-20 pages) on the topic of the student scientific research. Both types of credit work allow students to demonstrate not only the research results, but also their readiness to make public speech in English on a professional topic. Graduates should be encouraged to organize their presentations so that their content is clear to all groupmates. This will stimulate the interest of the audience and encourage discussion. Abstracts should be designed in accordance with the requirements to scientific publications of ranked scientific publishers.

A sample survey of graduates of the program "Digital technology in Power Engineering", who have finished training in the discipline "Professional Training in English" in the classroom and joined to online course on the LMS Moodle platform (initiated by pandemic COVID-19) are represented in Table 3.

The 38 Master's degree students of the School of Power Engineering were asked to evaluate their attitude and impact of different types of tasks to their educational activity and future specialty. Assessment is distributed from 1 to 10 (1 is minimally expressed, the 10 strongly expressed).

The statistics show that students were enthusiastic at the online course education from the middle of March to the end of June 2020. A comparative analysis of the frequency graduates visited course to view tasks (Figure 6.) and to post their answers (Figure 7.) illustrates fair stable activity [16]. The bottoms of curves at are explained by bank holidays in Russia and schedule of the discipline. The peaks coincided with the most interesting tasks in the course (like drawing single line diagram of power plant according to the text provided) and is proved by anonymous survey (Table 3).

The statistics findings indicate that the tasks focused on more professional skills are favourable by future specialists in power engineering. At the same time, it was noticed that some peaks may be explained by the

discipline module with absolutely new authentic information for students about digital technology. For example, FOCS (fibre optic current sensors). At that moment, this topic was not included in any discipline syllabus in Russian.

Table 3. Survey of students

Type of tasks	Profes-sional inte-rest	Practical usefulness for educational activity	Indepen-dent study workabi-lity	Possibility to online course adaptation
1. Video + text with gaps	8	10	5	9
2. Constructive task with audio (graphs, tables, pie charts analysis by students)	9	10	8	10
3. Project task	10	9	8	8
4.Professional simulator	10	10	8	9
5. Test, quiz	7	7	7	9
6. Professional discussion	10	9	8	5
7. Final presentation of research results	8	10	9	9

The experience of various types implementing distantly allows us to declare about the impossibility to organize the professional discussions. This is due to both the technical problems and the necessive emotional mood of students, which inspires to discuss the professional issues.

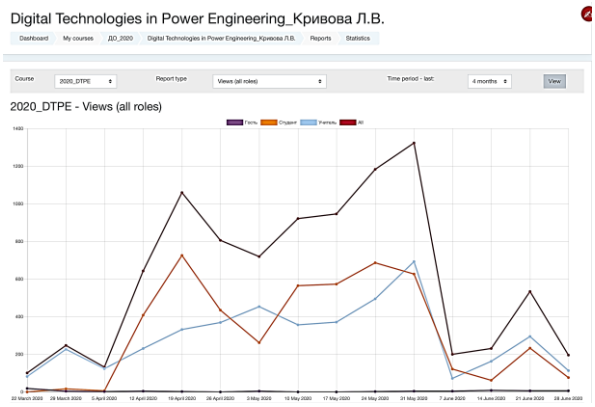

Figure 6. LMS Moodle statistics by views [10]

The analysis of teaching experience allows the authors of this article to conclude that tasks that use active teaching methods are most interesting to students. With the introduction of distant education, students have new opportunities to study subjects at a convenient speed, acquire skills and abilities not only traditionally, but also using simulators, and have 24 hours access to educational materials. The difficulties that arise when performing certain tasks are caused, in some cases, both by the poor language training of the student himself, and the lack of assistance from the teacher at the time of completing tasks individually.

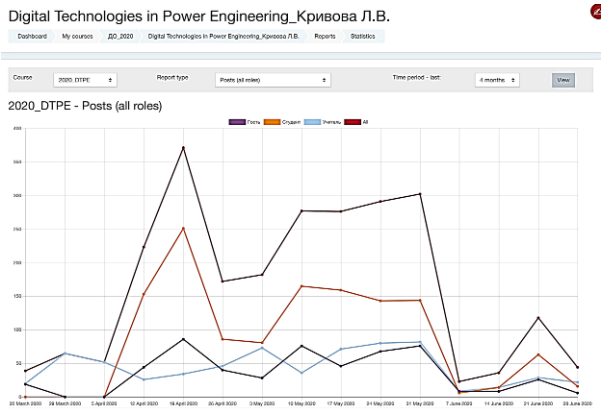

Figure 7. LMS Moodle statistics by posts [10]

The application of LMS Moodle to the independent work of Master degree students leads to higher results in syllabus outcomes and marks the beginning of the formation of a new curriculum aimed at new engineering, pedagogical, and linguistic approaches to delivering classes - the training of future frontiers in power engineering industry.

3. CONCLUSIONS

Professional training of future specialists in Digital Technologies of Power Engineering cannot continue to be based on the traditional methods in education, which is characterized by the lag of the syllabus and its content from the modern state of technology. Enterprises are more interested not just in a specialist who knows the basis in their professional field, but also ready to make a decision outside the framework and stereotypes, to innovate, to create [17, 18].

It is obvious that at present the task of University is to organize cognitive activities of students using the most progressive and sometimes futuristic ideas, to motivate them to acquire new knowledge and information, and to form a creative component in the search for solutions to professional problems. One of the main tasks of modern education is to create an environment for the formation of a creative approach to future professional activities: the origination of new, innovative ideas, developments and improvements.

An integral part of such an educational environment is the global technical equipment of the educational space: constant Internet access throughout the University and campus, classrooms with monoblocs and a projector, professional simulators and so on. The role of the teacher becomes more complex, since it changes from a "knowledge translator" to an effective manager of educational activities, who have to inspire students for conducting experiments, searching new ideas in professional field. Delivering classes on professional training in non-native language requires the teacher to have a deep knowledge of the professional field, English language proficiency, as well as the basics of linguistics and pedagogy.

The proposed forms and content of offline and online classes can be successfully applied to:
- courses for improving the language skills of engineering personnel of power enterprises,
- courses for improving the skills of University teachers who provide the study of the discipline "Professional training in English",
- courses for graduate students of Power Engineering Department (in preparation for passing the candidate's minimum in English.

There is no doubt that developed approaches may be successfully applied to professional training in English of students from other engineering departments, as well as for other Master's degree programs of technical profile.

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BIOGRAPHIES

Lyudmila V. Krivova was born in Voroshilovgrad, Ukraine, Soviet Union, 1974. She graduated from the Tomsk Polytechnic University, Tomsk, Russia as engineer in 1997 and received the Ph.D. degree at Novosibirsk State Technical University, Novosibirsk, Russia in 2003. Currently, she is an Associate Professor of School of Power and Power Engineering at the Tomsk Polytechnic University and involved in international program of Master degree students training visiting Professor at the Peter the Great Saint-Petersburg Polytechnic University. In spring semester 2005, she delivered lectures in University of Ulsan, South Korea. She also received the ING-PAED-IGIP diploma in 2006 and included in the Register of International Engineer-Teacher. Her research interests are in the area of Power Engineering, structural and functional reliability of power plants, digital substations, pedagogy, and some aspects of linguistics. She has published over 30 scientific papers and 1 monograph.

Vasiliy Ya. Ushakov was born in Kazakstan, 1939. He received Ph.D. degree in 1965 and Doctor of Science degree in 1973 from Tomsk Polytechnic University, Tomsk, Russia. Currently, he is a Professor of School of Power and Power Engineering at the Tomsk Polytechnic University. In different years, he held the following positions: the Head of High Voltage Department of the Tomsk Polytechnic University (TPU), the Head of High Voltage Research Institute at TPU, the Vice-rector for Research of TPU, the Head of Regional Resources Saving Centre. He has many years of experience teaching special disciplines ("High-voltage engineering", "Electrical engineering. Current state, problems and perspectives", "Energy saving in the enterprises of fuel and energy complex") in Russian and in English (including abroad – South Korea, spring 2005) and the course "Professional English" for Russian-speaking students. He has published over 300 scientific articles and 24 monographs and textbooks (four of them in Springer Verlag), received 38 invention certificates and patents. Under his leadership, 34 candidate and 6 doctoral dissertations were defended. He is currently a member of the Editorial Board of the journal "Russian Physics" and participant of Dissertation Council in the Tomsk branch of Russian Academy of Sciences.