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CREATING TEACHING MATERIALS FOR INTERNATIONAL STUDENTS

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Abstract

The problem of teaching an engineering discipline to non-native speakers is challenging and it requires the combination of active teaching methods. The authors determine the course content based on state-of-the-art reference sources and developments of the Electrical Engineering Department for students trained as part of academic exchange. The paper deals with creating teaching materials of a technical discipline for international students as illustrated by the Dispatching Control of Electrical Power Systems course. The paper describes methods and forms of training process, including active ones. We made an attempt to summarize the world experience of using active teaching methods to create the methodological materials for a new course to be delivered to international students. When creating a new course, we used our own experience of delivering a similar course supported in Moodle. Activity-targeted technologies can be an effective way for students to solve practical tasks of operational management in the electric power industry. Learner-centered technologies improve students' abilities to handle stress and assume responsibility in professional choice situations. The experience of creating the teaching materials for the course Dispatching Control of Electrical Power Systems for international students shows that active methods of teaching professional engineering disciplines are indispensable for successful professional training and overcoming the language barrier. Students can apply the knowledge and skills acquired not only in business games but also in their professional activities.

Keywords: International Students, Business Game, Skills, Course Learning Outcomes, Training Technologies..

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1. Introduction

Many authors have discussed the problem of the quality of education in general and engineering and technical one in particular, also by active teaching methods, e.g.: (Achim, Popescu, Kadar, & Muntean, 2013), (Angelova Stefanova, 2014), (Azeiteiro, Bacelar-Nicolau, Caetano, & Caeiro, 2015), (Blin, & Munro, 2008), (Zaripova, Shaidullina, Upshinskaya, Sayfutdinova, & Drovnikov, 2014).

A. A. Verbitskiy emphasizes that the strategic aim of university educators is not to increase the volume of information to be delivered or "archive" it or accelerate the perception processes, but, rather, to create the didactic and psychological conditions of meaningful learning, involving the student at the level of not only the intellectual activity but also personal and social one (Verbitskiy, 2011).

Authors also understand that the problem of teaching an engineering discipline to non-native speakers is challenging and it requires the combination of such teaching methods that would allow a student to concentrate on the content of the exercises rather than on their form (Hercika, Milkovab, & El-Hmoudovab, 2015). At the same time, an engineering course with an abundance of textual information may be difficult for students to master (Hamoudaa, & Tarlochan, 2015). Authors need to arrange the teaching system in a special way, so that extensive textual information in a non-native language would not stifle the training process for the students. E-learning is worth paying attention to as well. Flexibility and convenience offered by modern methods of e-learning were among the major factors of their worldwide popularity (Tîrziua, & Vrabieb, 2015).

Authors made an attempt to summarize the world experience of using active teaching methods to create the methodological materials for a new course to be delivered to international students at the Department of Power Grids and Electrical Engineering. In addition, when creating a new course, we used our own experience of delivering the similar course, Operational Management in Power Engineering (Khrushchev, Batseva, Fix, Chesnokova, & Khar'kovskaya, 2015), (Fix, Kolesnikov, & Petrova, 2015), (Batseva, Fix, Pankratov, Troshchinskiy, & Petrova, 2016), (Batseva, Fix, Mitrofanov, & Petrova, 2016) supported in Moodle learning management system.

2. Problem Statement

Dispatching Control of Electrical Power Systems is the course that belongs to the master training program Electric Power Engineering and Electrical Engineering (specialization: Design and Control of Smart Power Systems). The discipline is one of the major subjects and has an independent value. So far, it only includes the teaching package and its support in the Moodle learning management system is under construction.

This course has the following objectives: training students in knowledge of technical processes, circuits, power engineering equipment, understanding of technical processes, knowledge of operational code for electrical installations, knowledge of electrical safety rules, obtaining skills of power management of power networks.

It deals with the key functions of operational dispatch management as well as the economic factors of electric power generation and transmission. It also discusses the main factors of safety and reliability in both normal and emergency operating conditions as well as the system operators training for emergency events.

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In order to successfully master the discipline, students need to know the following: fundamentals of power generation; consumption and Smart Grids; schemes and equipment of electric power stations and substations; schemes of power systems and networks. They also need to be able to use the methods of analysis, modelling and calculation of the modes for a complex power supply system.

Students taking this course should have some background in power systems or very good backgrounds in electric circuits.

In a priority these disciplines required the Dispatching Control of Electrical Power Systems course (prerequisites):

- Computer, networking and information technologies;
- Additional chapters of mathematics (numerical methods);
- Philosophical and methodological aspects of science and technology.

The content of the Dispatching Control of Electrical Power Systems course is consistent with disciplines studied in parallel (co requisites):

- Designing of electrical power systems and networks;
- Methods of stability calculation;
- Flexible AC transmission systems;
- Emergency control of power systems.

The syllabus is developed in compliance with the Primary Curriculum Standard of Tomsk Polytechnic University and meets the requirements of the Federal State Educational Standard for the specialization of Design and Control of Smart Power Systems.

3. Research Questions

The paper deals with creating teaching materials of a technical discipline for international students as illustrated by the Dispatching Control of Electrical Power Systems course. The paper describes methods and forms of training process, including active ones. We made an attempt to summarize the world experience of using active teaching methods to create the methodological materials for a new course to be delivered to international students.

4. Purpose of the Study

When creating a new course, we used our own experience of delivering a similar course supported in Moodle. Activity-targeted technologies (game simulation of technological processes) can be an effective way for students to solve practical tasks of operational management in the electric power industry. Learner-centered technologies (interactive and imitation games) improve students' abilities to handle stress and assume responsibility in professional choice situations, e.g., when tackling the challenges of operational dispatch management. The experience of creating teaching materials for the course Dispatching Control of Electrical Power Systems for international students shows that active

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methods of teaching professional engineering disciplines are indispensable for successful professional training and overcoming the language barrier.

5. Research Methods

The following research methods were used: analysis, synthesis, classification, systematization and generalization of facts and information, comparisons, testing, questioning, observation, description, design, modeling, pedagogical experiment

6. Findings

6.1. Course structure and content

The content is based on state-of-the-art sources of reference (Bevrani, 2014), (Gomez-Exposito, 2009), (Momoh, & Mili, 2010), (Savulescu, 2009), (Vasant, 2012), (Wood, Wollenberg, & Sheblé, 2014) as well as the developments of the Department of Power Grids and Electrical Engineering. At this point we have developed a course of lectures as well as methodological materials for laboratory work and self-study. The course consists of two main sections.

Section 1. Power system operation and management:

- Course introduction. Basic concepts and definitions.
- A historical approach to the electric power sector. An outline of trends in the Power Industry.
- Electric power systems (EPS) from physical and operation perspectives.
- Demand of electricity; production, technologies, equipment, fuels, networks, metering and communication, control centres.
- Organization of the power sector. The hierarchy of decision-making processes in the traditionally regulated power sector. Equivalent functions under a competitive regime.
- Management and control of energy systems and usage of energy resources.
- Dispatching and control functions at various levels.
- Wholesale and retail electricity markets.
- Role of an Energy Management System (EMS) in the overall Smart Grid.

Section 2. Power system control and analysis:

- Power system operation and control in modern power system control centres.
- The real-time and study-mode data environment in modern Supervisory Control and Data Acquisition (SCADA)/EMS.
- Operations training simulators.
- Operator training simulator FINIST.
- Operating states of a power system.
- Power system security analysis. Organization of dispatch control.
- State estimation in power systems.
- Primary, secondary and tertiary regulation.

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- Control of normal operation of power systems.
- Voltage control in networks of interconnected power systems.
- Load forecasting technique.
- Voltage stability.
- Power quality. Definitions and standards. The National Electric Code.
- Emergency control of power systems.

The types of training activity include lectures and laboratory works.

Laboratory works take the form of business games (Greco, Baldissin, & Nonino, 2013), e.g.:

- Business game Learning the System Behavior and Practicing Operator Actions during Routine Situations.
- Business game Steady State Regime Restoration after Emergency Shut-down of Interconnection Transmission Lines with Power System – 1.

6.2. Training technologies

By business games authors mean creating such situational models that would help our students improve soft skills such as decision making, negotiation, and communication (Chapman, & Martin, 1995). Also, we believe that business games can help us teach our students cooperate with other people in the decision making process, when in the actual business environment (Savolainen, 1997). Here we need to keep in mind that all the business games are in a non-native language for the students, which brings about such a constraining factor as language barrier that we need to overcome.

6.3. Learning outcomes

Mastering the Dispatching Control of Electrical Power Systems course will enable the students to achieve the following learning outcomes with the help of the following training technologies (Table 01).

Table 01. [Methods and forms of training process organization]

Methods	Forms of Learning Activities		
	Lectures	Laboratory works	Self-guided work
IT methods	x	x	
Teamwork		x	
Case-study		x	
Game		x	
Problem training methods		x	
Experience-based training		x	x
Advanced self-guided work		x	x
Search method			x
Research method		x	x

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Students' self-guided work includes everyday and creative problem-oriented independent work.

Everyday independent work is focused on extending and reinforcing students' knowledge and developing practical skills. It comprises working with lecture materials, looking for and reviewing the literature and electronic sources of information in compliance with an individually predetermined course problem; proactive self-study; getting prepared for laboratory work; getting prepared for a credit test or examination.

Creative independent work includes: looking for, analyzing, structuring and presenting information; research work and taking part in students' scientific conferences, seminars and academic competitions; analyzing academic publications under the topics predetermined by the professor.

The results of self-guided work are to be assessed in the following way: control questions; exam questions.

The following tools are meant for assessing the course learning outcomes as part of the control procedures: incoming control questions; control questions to be asked during performance and defense of laboratory work; questions to be asked during credit tests and examinations.

Formative assessment includes such questions as:

- What is meant by the terms primary, secondary, and tertiary regulation?
- What are the essential features typical of dispatch control of voltages existing on electric networks?
- What is the principal goal to be attained during dispatch control?

Summative assessment includes such questions as:

- Control of normal operation of power systems.
- Operating states of a power system.
- Voltage stability.
- Power quality. Definitions and standards. The National Electric Code.
- Emergency control of power systems.
- Operations training simulators.

During formative and summative assessment, the course learning outcomes are to be evaluated in compliance with the guidelines for ongoing control over academic progress and summative assessment of students at Tomsk Polytechnic University (Chubik, 2013).

In accordance with the course progress chart:

- Formative assessment, which involves evaluating the quality of mastering theoretical materials (answers to questions, etc.) and results of practical activities (solving tasks, performing exercises, solving problems, etc.), is carried out throughout the term (assessed in credits (no more than 60 credits). By the end of the term, students must collect at least 33 credits.

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- Summative assessment (examination, credit test) is carried out at the end of the term (assessed in credits (no more than 40 credits). Students must collect at least 22 credits at an exam (credit test).

In 2015/2016 academic year, the Department of Power Grids and Electrical Engineering organized training for a group of international students in a number of technical disciplines as part of a pilot project within the program of Electric Power Engineering. Most students did not only master the theoretical and practical material successfully according to our assessment (the average academic progress was approximately 90 points out of the maximum 100). According to a survey, they were also satisfied with the quality of training and showed further willingness to study with the help of active training methods.

7. Conclusion

The experience of creating the teaching materials for the course Dispatching Control of Electrical Power Systems for international students shows that active methods of teaching professional engineering disciplines are indispensable for successful professional training and overcoming the language barrier.

The system approach to teaching specialty courses makes it possible to present the learning materials in different ways, combine various teaching technologies, control the quality of training, use the individual approach and manage independent work of students.

Using brain-targeted technologies, such as dialog-based teaching methods, discussion seminars, problem-based learning, cognitive instruction facilitates teaching engineering disciplines and developing professional competences in each discipline.

For instance, after completing the course Dispatching Control of Electrical Power Systems, students must achieve the following results (planned course learning outcomes):

- Knowledge of technical processes, circuits, power engineering equipment, understanding of technical processes, knowledge of operational code for electrical installations, knowledge of electrical safety rules, obtaining skills of power management of electrical power network.
- Being able to solve the problems associated with power system optimization as applied to all the stages of energy production, decision making, long-term and short-term planning, performance updating, and real-time control.

To form professional competences and learning motivation, we suggest using business games as an active teaching technique, which is an efficient tool to prepare students for future professional activity. Business games, as a tool for simulating various aspects of professional environment and real industrial processes, allow training students to apply the obtained theoretical knowledge and solve problems emerging in their professional activity.

Activity-targeted technologies (the methods of projects and guiding texts, context teaching, organization and assignment games, technological maps, complex tasks, and game simulation of technological processes) can be an effective way for students to solve practical tasks of operational management in the electric power industry.

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Learner-centered technologies (interactive and imitation games) improve students' abilities to handle stress and assume responsibility in professional choice situations, e.g., when tackling the challenges of operational dispatch management, which do not only require these qualities from a dispatcher but also high reaction rate.

Preliminary results showed in a more productive teaching process arrangement. In the future, we plan to improve the methodological materials for the Dispatching Control of Electrical Power Systems discipline, to use Moodle learning management system for presenting the learning materials in the multimedia form and for knowledge assessment by means of tests and to create new business games. Students can apply the knowledge and skills acquired not only in business games but also in their professional activities.

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