Chapter 12
Towards Smart Education and Lifelong Learning in Russia

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Abstract This paper describes the experience of introducing smart technology into the educational process at a Russian university between 2010–2016. Particular attention is paid to such innovative and smart techniques as training sessions, group teaching methods, role-playing games, the use of smart components, etc. The authors propose a method to enhance students' motivation for independent and life-long learning. This approach was trialed with students majoring in power engineering and the results are discussed. The main challenges in introducing smart technology are described, and areas for future development and improvement are identified.

Keywords Smart technology · e-learning · b-learning · Independent learning · Lifelong learning

12.1 Introduction

In the 21st century, engineers and university graduates need to be able to find information, making use of scientific and technological innovations, and interact with colleagues abroad. Moreover, innovative solutions to professional problems require a new approach. Universities should therefore focus on the individualization of professional training using smart technology. In this context, a new approach in the educational process (smart technologies) provides universities the opportunity to meet the requirements of consumers and employers. Smart education is a new educational paradigm that involves the implementation of an adaptive educational

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process using a range of smart information technologies. Smart education should provide the opportunity to benefit from the global information society, and to meet educational needs and interests [1].

The educational system in Russia is not immune to the influence of economic and geopolitical factors. One of these factors is the network economy that underpins international cooperation. In the context of globalization, academic mobility is one of the most crucial indicators of assessment for university performance, as well as the quality of education overall. Thus, globalization processes create a need for new forms of education, such as intercultural and transnational education. In Russia, the reforms envisaged by the Bologna process are now being felt by universities [2]. Internationalization of higher education requires the development and accreditation of modern curricula as well as new, more effective teaching techniques. Innovative technologies such as smart technologies determine the attractiveness of a university in the educational market. Their use meets the requirements of the educational environment, namely, to cater for a wide variety of all possible participants of the educational process.

The advantages of using smart education are in its unique ability to apply modern Information and Communication Technology (ICT) in: (1) the educational process; (2) new methodological and pedagogical educational approaches; (3) classrooms, (4) independent learning, etc. [3]. Smart technologies such as:

1. open educational resources for information (in addition to lectures, seminars, books, etc.);
2. new student-teacher and teacher-student relations;
3. a new testing and assessment approach;
4. a new approach to organization of communities (Internet community, professional community, etc.)

enabling restructuring of the educational process.

Rapidly evolving technologies lead to the rapid "aging" of knowledge (about 15–20% per year) [4]. Therefore, most obtained knowledge may become irrelevant within 3–5 years. In this case, the crucial goal of modern education is to develop self-learning skills and provide motivation for lifelong learning. Moreover, a smart approach to the educational process provides a wide range of possibilities for e-learning, blended learning (b-learning), etc.

The introduction of e-learning began in South Korea in 1997. Currently, there are 20 cyber universities with electronic educational services. Smart Education in South Korea is based on the concept of the country's competitiveness growth with limited natural resources. This is supported by the World Bank defining the category of "national wealth" as equal to 5% of natural resources and 77% of knowledge and skills.

In the modern world, traditional approaches may not be suitable for solving certain engineering challenges. Consequently, we need specialists who can quickly respond to any changes in the environment, to adapt to them, and to be engaged in continuous self-education. A modern specialist can be educated only through direct

interaction with the professional community. A combination of group teaching methods, game teaching methods, interactive tutorials, and student collaboration connects students, teachers, and instruments, thus enriching the learning process. In this case, a smart environment and smart instruments support smart learning but are not sufficient in themselves. When introducing smart technologies to the educational process, the following aspects are especially significant:

- the readiness of a teacher to use smart technologies;
- the psychological and social features of students;
- a combination of student-centered, communicative, and socio-cultural approaches; and
- use of modern pedagogical principles.

A teacher should have creative skills, which allow him/her to leave behind professional stereotypes and find new solutions. In addition, in using smart technologies a teacher is able to minimize students' feelings of anxiety and uncertainty, which are typical for freshmen.

In our opinion, organizing a learning process based on teacher-student cooperation seems to be the most effective approach. Cooperative learning promotes student adaptation to the new environment, their personal growth, and professional development.

12.2 Literature Review

Issues of professional education have been widely discussed for an extended period of time. Since the middle of the 20th century, associations of engineers have been formed, followed by the establishment of engineering educational associations around the world. The latter have formulated requirements regarding graduates of engineering programs; however, the best ways to fulfill their sets of criteria are still discussed.

12.2.1 Student-Centered Approaches

It has been observed that the inclusion of scientific and engineering tasks in theoretical disciplines improves the learning outcomes of freshmen students [5]. Several universities have implemented Project-Based Learning in Engineering [6]. Universities are not always ready to undertake such drastic reforms, but they are forced to find and implement new approaches. For instance, in [7], the author emphasizes a new approach based on supervising students rather than traditional teaching. This method enhances student motivation to find correct answers and new ideas while broadening students' scope of interests. The author of [7] develops new

social learning technology using existing ones: ontologies versus social tagging, exploratory search, trust, reputation mechanisms, etc.

Modern Digital Natives (students) make university faculty develop various distance learning platforms and online content. The new generation of students is accustomed to rapid satisfaction of their interests, so they strive to be involved in creative processes, gamification, and collaboration with fellow students and other participants of the educational process [8]. The authors believe that the socio-psychological characteristics of today's students require the creation of a new educational environment that meets their needs. In [9], principles were formulated that should be incorporated into the educational process to encourage students toward a lifetime of learning. It is assumed that lifelong learning skills are based on the skills developed while studying at school and university. It should be assumed that open, context-aware, ubiquitous learning environments are intended to be a foundation for supporting lifelong learning [10]. The authors develop criteria for a smart learning environment and note that the presence and promotion of new computer, communications, and sensor technologies are not sufficient to create such an environment. The creation of a smart learning environment should involve experts in different fields of education: educational theory, psychology, computer science, information technology, and, of course, college professors, academics, and school teachers. A properly designed educational environment is required for both online and face-to-face activities.

Issues of motivation have been widely discussed, both in Russia and abroad. For example, Kegan [11] developed a 6-level model of student motivation based on Maslow's 5-level model [12]. This model enables the determining of the initial level of student motivation and developing an individual learning path in order to enhance intrinsic motivation, which is an important factor in the success of educational outcomes.

12.2.2 Learning Systems

Nowadays, educational systems aim to make use of innovative approaches. One of the most popular forms of innovative education is smart education. Components of smart education (a smart environment, smart campus, smart learning, and smart classroom) are described in [3, 13, 14] in detail. Based on an analysis of traditional and distance learning, the authors conclude that properly organized e-learning and innovative tools (online counseling, webinar, digital white boards, online assignments, etc.) do not lead to a deterioration in the quality of learning outcomes. This is supported by a comparative analysis of ranking scores.

According to Tikhomirov [15], e-learning is becoming routine; however, the question of students' readiness for e-learning is still under discussion because e-learning is actually independent study. Education is a complex process comprised of the accumulation and transformation of knowledge, mindset formation, and formation of a personality that is ready for self-development. It is believed that

innovations in the educational process improve the efficiency of cognitive processes and positively influence the quality of outcomes. A good example of innovative technology being implemented intensively throughout the world is blended learning. Concurrently, methods for the analysis and monitoring of learning outcomes are being developed [16].

Learning management systems (LMS) such as WebCT, Moodle, dotLRN, etc., are widely recognized as reliable control and management systems in education. In a study of blended learning and student satisfaction, it was shown that online teacher-student communication is not effective [17]. A survey reported in [18] shows that 84% of respondents noted that online feedback was unsuccessful and only 1% received too much feedback online from their teacher. Forty-six percent did not receive sufficient helpful online feedback from their teacher as opposed to 15% who actually received sufficient help. Students were satisfied, however, by the organization of the e-learning systems: 69% of students responded saying that they understood how the website for their unit related to the whole unit of study. In [19], over the course of 4 years, a blended model was examined in order to analyze its effects on the quality of education as well as the opinion of teachers and students regarding the model. The authors showed that both students and teachers had a positive attitude toward e-learning. The students involved had a unique opportunity to study subjects according to their own day plan, to use IT tools for acquiring skills, and to have free access to teaching aids. Moreover, they were emphatic that the knowledge assessment system became more understandable. While there were positive responses, the surveys also showed that the quality of communication between students and teachers was deteriorating. Forums and chats cannot substitute face-to-face communication. Some universities, though, such as Illinois State University and Idaho State are developing a variety of pedagogical concepts and technologies based on b-learning and implementing them at different levels of education (middle school, high school, university) [20].

12.2.3 Integrating e-Learning

In [21, 22], existing schemes of e-learning integration in the educational process are described in detail. It is noted that the development of e-learning courses for theoretical disciplines met some challenges. Although e-learning is an appropriate means of practicing lifelong learning, it does not provide future engineers with deep theoretical knowledge. This theoretical knowledge is developed only by personal communication with a teacher. The study [23] included a comparative analysis of a survey of the mobile learning preferences of faculty involved in teaching language and science courses. Aspects such as ease of use, continuity, relevance, adaptive content, multiple sources, timely guidance, student negotiation, and inquiry learning were examined. The authors found significant differences in the requirements for mobile language and science courses. Therefore, according to the language specialists' opinion, adaptive content is a key part of a mobile course. This

enhances teaching effectiveness and improves students' learning outcomes, yet teachers of theoretical disciplines believe that a mobile learning environment and interaction or inquiry learning in the real world are more important. These conclusions are consistent with additional studies [17, 18]. Because of this, the authors of this paper suggest an individual approach and appropriate methodology for designing a mobile course. In addition, the structure and the content of a mobile course depend on the learning strategy (b-learning, e-learning, etc.). For instance, teachers are skeptical about studying higher mathematics using e-courses. This is explained by the fact that successful studying of mathematics is based on the development of skills and subjects, which can be achieved by adhering to the following components:

1. Acceptance: intention to learn mathematics;
2. Reaction: intention to participate in math activities;
3. Value: active acknowledgement of the practicality of mathematics and promotion of math activities;
4. Organization: integration of mathematics concepts into the student's personal value system; and
5. Confirmation of value: personal identification with math concepts and values [24].

Some e-courses are used solely as an e-library with teaching materials uploaded. Good examples of the successful introduction of an e-course are provided in [21, 25]. The authors utilized e-courses to teach a theoretical discipline to first-year students. The problem solving portion of the course was conducted online. In this case, the problem solving was checked by the teacher and automatically assessed. Only student counseling was arranged face-to-face. The students successfully completed all the online tasks before being permitted to proceed to the exam. Theoretical tasks and issues were discussed during lectures, understanding of which was assessed in the exam. The authors considered the experiment a success due to the fact that only those students who completed the e-course management to pass the exam with the highest grades.

Despite sustained discussions about the inclusion of industry representatives in the educational process as active participants, only a few papers are devoted to this issue. Most examples relate to medical social worker education and describe the experience of collaboration with organizations during senior undergraduate courses, as well as at graduate levels. For instance, [26] examines an interdisciplinary project in bioprocess production between graduate students and industry representatives. Such an approach not only motivated the students, stimulating their creativity, critical thinking, collaboration, and communication, but also allowed the students to gain expertise in allied professions, as well as establishing contacts with representatives of laboratories and companies producing biotech materials. The most appropriate scheme for engineering education is a gamification model. In [27], there is a comprehensive overview of existing models of gamification. The paper also describes in detail the author's model of using smart technology based on external

motivational tools, which was implemented in the educational process. The authors conclude that the main goal in successful learning—motivation of students—was mostly achieved.

12.3 Goal and Objectives

The literature shows that the introduction and use of smart technology is still open to discussion. In higher education, there is no universal tool in the development of new approaches to smart education. Independent learning and motivation to lifelong learning, in our opinion, could be considered key elements of smart education. In addition, we offer a unique method for involving students in the work of professional communities from the earliest days of study.

Nowadays, educational systems are attempting to meet the needs of national economies throughout the entire world. Universities are forced to adapt to employers' requirements. In modern conditions, a stereotypical approach in solving professional problems may not be suitable in some cases. Consequently we need specialists who can quickly respond to any changes in the environment, and who are continuously engaged in their own professional development. Modern freshmen often have obscure ideas about their role in the educational process at their university, about the amount of new information they will obtain, and their future specialty. A properly organized educational environment would help students quickly adapt to their new lifestyle.

University years coincide with a period of intensive personal development in a physical, intellectual, social, and moral sense. While attempting to adapt to university life, the educational system and university relationships could prove challenging to new students. A successful start in the learning process requires students to have qualities such as self-discipline and self-organization. They became accustomed to parents' and school teachers' assistance to the point that finding themselves in a new environment leaves some freshmen diffident, burnt-out and passive, gradually losing grasp of the prospects for furthering their studies. However, not only students, but also faculty, are interested in effective student adaptation to university life [1]. In this case, one of the main challenges for academic staff is helping students during their social, psychological, and academic adaptation to university life; forming soft skills as well as necessary professional and general cultural competencies as part of student academic activities; and developing their personal academic pathway. Moreover, it is crucial to motivate independent learning and the development of special learning skills.

The problem of fostering motivation for independent and lifelong learning has been well studied. Some papers present a statistical analysis of low motivation problems and provide some recommendations for its improvement. Some methods for increasing motivation show a positive result, but are strictly limited to specific conditions. Modern education requires universal methods for developing student motivation for independent and lifelong learning. Let us note that, in Russia,

priority is traditionally given to theoretical disciplines. Faculty attempt to resist replacing theory with professional disciplines. In the situation of decreasing face-to-face hours, faculty strive to preserve a deep theoretical education and often invite students to study theoretical and unresolved issues and problems independently. However, first-year students generally do not have the skills to gain the knowledge that they need. These skills should be taught, and the introduction of new educational technology should meet teaching objectives and be monitored at all levels of learning outcomes.

One of the key principles in education should be the organization of a smart environment based on the principles of "inverted" education, modified to develop motivation for independent learning ("role reversal education"). "Role reversal" education is an educational model where the students initially obtain information on a specific topic independently. The students then discuss this topic with their teacher and fellow students in the classroom. As a result of the discussion, this new information becomes a basis for further research. Moreover, some courses are taught in English as this model of education involves global educational content in order to acquaint students with the latest developments and achievements in their chosen profession. When introducing the principles of "role reversal" education, a teacher should "claim ignorance of the topic" and discover it together with the students, thereby creating an atmosphere of close collaboration and cooperation in cognitive activity. Using this approach, knowledge of theoretical disciplines will be a vital tool for the development of interdisciplinary problem-solving skills.

Thus, the goal of our study is to create an educational model that takes advantage of smart technology and the principles of lifelong learning in order to achieve the sustained involvement of students in education inextricably linked to professional skills. For the achievement of this goal, we have set the following tasks:

1. To organize an educational smart environment that requires free access to all educational resources, modern equipped classrooms, etc.;
2. To develop students' skills for independent learning;
3. To enhance students' motivation for lifelong learning; and
4. To create a curriculum that includes the interaction of students with professional communities.

12.4 Theoretical and Methodological Framework

Professional training of modern specialists can no longer be based on the traditional approach in higher education, when paradoxically the equipment and technology of the workplace are ahead of the educational program and its content. Companies are more interested in a specialist who knows not only the fundamentals of their specialty, but who are also able to break stereotypes, to innovate, and to create.

12.4.1 Organization of Smart Education

One of the major roles of a university is education. Nowadays, universities use the most progressive and sometimes even futuristic ideas to motivate students to acquire new knowledge and information, and to form the ability to find creative solutions to professional tasks. Thus, one of our objectives is to create a smart environment that will support a creative approach to professional activity. It is expected that this approach will lead to forming students' skills in generating innovative ideas, developments, and improvements. An integral part of such an educational environment is global technical equipment: unlimited access to the Internet at the university and campus, classrooms with projectors and smart boards, classrooms with student feedback, and modern equipped laboratories. For the organization of student independent work and cooperation, we use the LMS Moodle.

Cooperative learning. In this case, the role of the teacher becomes more complicated. Teachers are no longer "a translator of knowledge". Rather, they become effective managers of educational activity known as smart teachers. A smart environment and smart teacher are the main components of introducing a smart approach. In addition, a modern specialist should be properly educated in cooperation with the professional community.

Since 2010, at the Department of Electric Power Systems at Tomsk Polytechnic University (TPU), a group of 10 masters' students have been annually recruited to study on an individual educational pathway plan for a two year period. At the same time, power company specialists are involved in the educational process ensuring that classes are delivered not only by university staff, but also by the best specialists in this area. Laboratory work is organized using real equipment and the input data are approximated to reality. Practice is organized individually to involve students in solving professional tasks in lifelike conditions. As a result, we have a unique circle of cooperation that involves students, faculty, and the professional community in the smart environment (Fig. 12.1).

In addition to the above, the smart content is created, not only by faculty, but also with the participation of power industry specialists, as well as students (based on their questions and new ideas). Such an approach allows students to obtain

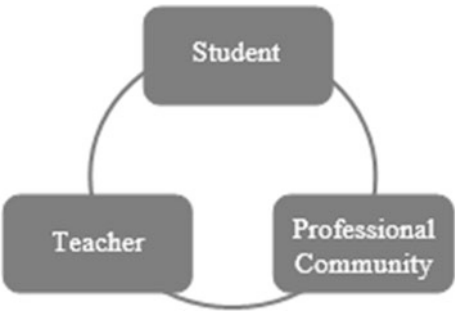

Fig. 12.1 Circle of cooperation

real-world knowledge that is applicable to their future professional activity. Thus, the university is becoming a place of professional independent learning.

Obviously, professional disciplines follow deep knowledge of theory. Therefore, interdisciplinary connection and a systematic approach are crucial for the successful development of professional skills. This should be achieved through specific tasks transformed from general theoretical knowledge to expertise. That is, students should always be sure that the knowledge obtained could potentially be applied in order to solve other more complicated and unresolved tasks. Group teaching methods and role-playing games are considered the most productive learning techniques. For example, the course "Power Stations (in English)" was delivered in classrooms with free Internet access and multimedia devices. The students were divided into three teams: one team of investors and two teams of power plant designers. The designers had to develop and present a new design of a power station without restrictions on the equipment and information used. The team of investors had to ask questions, discuss, and then choose one project for financial support.

Student motivation. To enhance student motivation to study professional disciplines in a non-native language, productive and reproductive types of tasks should be used. Unfortunately, not all students have sufficient language and professional skills, potentially leading to a number of difficulties with creative tasks. Simple tasks in combination with more sophisticated tasks will allow the potential of every student to be discovered and ensure a comfortable environment, developing professional language competence.

In addition to the basic educational program, students have the opportunity to participate in a double degree program. At TPU, an intensive language training program has been developed for students who would like to obtain a double degree diploma. This reinforces motivation for foreign language learning and for developing the professional competencies necessary for communication with colleagues from other countries. As noted above, independent learning is one of the main parts of the educational process. Nowadays, one of the most affordable methods for organizing independent learning at TPU is the LMS Moodle. To date, more than 1,000 courses have been developed and are being used for e-learning and b-learning. It should be taken into account that theoretical and professional disciplines require rather different approaches in terms of web-course development, as they are conducted at different levels of the educational process. Unfortunately, traditional and b-learning/e-learning models of education are not combined. This may be due to the unique set of tools of the discipline. A developer of a web-course has to not only be a creative specialist in the discipline, but also have knowledge of psychology from the content perception point of view. Therefore, the introduction of e-learning elements into the educational process requires analysis of their effectiveness.

To generate creativity and increase motivation for independent learning, the "role reversal" education method can be used. This method has been tested at the Department of Electric Power Systems for the discipline "Power Plants" for third-year students in the spring semester. Every student received an individual task

for presentation on a new, not previously studied, topic. This new knowledge was then applied to power plant design. Each student had to find a reasonable way to present new equipment, switching devices, and current-carrying parts for his/her fellow students. At the same time, in some cases, students found a piece of information that was new for the teacher as well. Additionally, a number of new questions, to which the students were not used to, arose when they were searching for information for their presentation. Presentations were discussed in the classroom, corrected, and uploaded to the LMS Moodle. Thus, the educational content was created together by students and instructors. This approach is based on the principles of free education when teachers and students study the subject together. This provides psychological comfort while studying a new discipline and gives understanding that nothing is static or predefined in the professional area of knowledge.

The link between education and professional activity. It seems reasonable to study a professional discipline first in Russian prior to in English, expanding the students' boundaries of knowledge. The field of knowledge of professional disciplines (in Russian) and general English can be presented as two areas of knowledge. As a result of their overlapping, professional training in English is formed (Fig. 12.2).

The greater the bilingual professional skills—the greater the area of the circles' intersecting will be. Ideally, the training of a modern specialist means a full overlapping of these two sections. Here we face some difficulties, primarily, the low motivation of students to study professional disciplines in English. Student surveys show that only 5% of students have intrinsic motivation to study a foreign language, i.e. students study the subject only because it is included in the curriculum. At TPU, classes of "Professional English Training" amount to 32 h per week, giving 108 h of tuition each semester for first-year masters' students in Power and Electrical Engineering. Such a quantity of hours is sufficient for the special training to use English in their education and future career.

Participation, collaboration and co-authorship should become central in educational activities for faculty, following the principles of smart education. The suggested ways of increasing students' motivation for studying professional disciplines in English have been partially introduced and yielded positive results, but could be expanded and supplemented. Modern students have to know English to possess

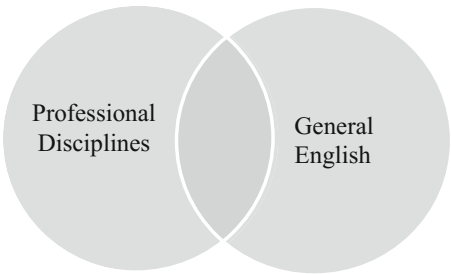

Fig. 12.2 Field of knowledge

Table 12.1 Necessity of using english in professional activity

Questions	Yes, %	No, %
Is english required to obtain new information necessary for solving technical tasks?	85	15
Did you have any difficulties with modern equipment if the manual and technical documentation were in english only?	95	5
Do you have to communicate with specialists from foreign companies without an interpreter?	60	40
Were you satisfied by the interpreter (translator) service?	20	80

relevant information on the issue. It is obvious that translating into Russian and publishing scientific papers, new equipment design, instructions, etc. takes some time and such knowledge eventually becomes irrelevant. Table 12.1 shows the results of a survey for the management of Russian power companies (78 managers and engineers in total).

As the table shows, the vast majority of managers need effective and confident English for any aspect of their professional work. Even an interpreter does not solve the problem of free communication and normal comprehension with their partners from other countries.

Thus, modern students have to study, at minimum, one foreign language to a level that allows them to use the latest equipment, read and understand texts on a subject in the original language, communicate with foreign colleagues, participate in scientific conferences, etc.

Moreover, the majority of research and scientific papers are written in English. Smart education is implemented by using numerous components [3, 13]. Various smart devices, approaches, etc. support the education of future specialists in the power engineering industry. Table 12.2 shows smart components and their use in teaching theoretical and professional disciplines at the Department of Higher Mathematics and the Department of Power Plants at TPU.

12.4.2 Supporting Smart Education

Each educational institution has a unique system of activities to develop students' personalities [15]. At TPU, guidance counseling plays a key role in providing the basis for the development of students' general and professional competences [28].

Being a connection between the freshman and a new community, guidance counselors of an academic group use active and interactive activities in the classroom and outside. These include role-playing games, psychological training, group discussions, museum tours, excursions to companies, arranging master classes by invited experts, meetings with representatives of companies, government, public organizations, etc.

Table 12.2 The major smart components used in the "role reversal" method

Smart technology components		Theoretical disciplines	Professional disciplines	Professional training in English	Professional communities
Hardware/ equipment	Ceiling-mounted projectors	Yes	Yes	Yes	Yes
	Smart boards	Yes	No	No	No
	Interconnected desktop computers	Yes	Yes	Yes	Yes
Smart curricula	Adaptive courses	Yes	No	No	No
	e-learning/b-learning modules	Yes	Yes	No	No
	Face-to-face modules	Yes	Yes	Yes	Yes
Smart pedagogy	Collaborative learning	No	Yes	Yes	Yes
	Student-generated learning content	No	Yes	No	No
	Gamification	Yes	No	Yes	Yes
	Project-based learning	No	Yes	Yes	Yes

Initial adaptation to smart education. All first-year students in the Institute of Power Engineering at Tomsk Polytechnic University (TPU) must take the Adaptation Course, which runs over two semesters. Classes meet for 2 h per week in the fall semester and 1 h per week in the spring semester, over 36 weeks giving 48 h of tuition. After taking the course, students are able to:

- prepare themselves for facing new academic challenges;
- improve their time management;
- freely navigate through the informational environment of the university and quickly receive all necessary information for study and leisure;
- present information clearly and effectively;
- make a speech confidently;
- work on their weak points after learning their traits and characteristics; and
- set and achieve goals.

The course is provided by proficient guidance counselors. At present, 17 guidance counselors work with first- and second-year students in the Institute of Power Engineering. All of them combine faculty positions (assistant professor or associate professor) with guidance counseling. One guidance counselor supports each student group.

The Adaptation Course contains 3 modules: "Informational," "Academic," and "Social and Psychological." The "Informational Module" includes introductory sessions on university life and the students learn to use the "New Student Guide", or guidelines for new students on how to start their learning process successfully. They also learn how to utilize the website to organize their student life including

schedule service, teachers' contact hours, campus map, etc. The "Academic Module" consists of workshops such as "E-services and the Educational Process in TPU," "Techniques for Working with Information," "Public Speech," "Cloud Technologies," etc. The "Social and Psychological Module" consists of psychological training such as "How to Set and Achieve Goals," "Time Management," "Know Thyself," "Stress Management," "Conflict and Reconciliation Behavior," "How to Pass Exams Perfectly Well," etc.

The aim of the academic and social adaptation project is to shorten the period of student adaptation, increase stress resistance, and retain students. The use of smart technologies, such as e-learning, b-learning, personalization, interactive tutorials, learning through video games, etc., allows young people to adapt to rapidly changing conditions and ensure transition from passive to active content. Over recent decades, the Internet has proven to be the most successful global project, changing the economy and society with new forms of communication and collaboration, implementation of innovations, and new modes of working with information and knowledge. Currently, electronic educational resources are an essential part of life for any person associated with education.

Firstly, all students receive access to all the information resources of the university, which will help them in solving various troubles, problems, issues, and challenges. After registration (receiving their username and password) as users of TPU's corporate network, every student is able to work with programs and services in a personalized enclosed space, or an individual student online service. In the individual student online service, a student and a guidance counselor have equal opportunities for communication together. Additionally, there is the possibility that students are given online counseling. Moreover, there is a series of tutorials, which helps students adapt to university life. For instance:

- "Virtual TPU"—students familiarize themselves with university information and the educational environment, namely, the resources and the services available for students; and
- "The basics of work with information and library resources"—students make themselves familiar with library resources, as well as rules and techniques for information processing. They obtain information about rare and unique resources, electronic catalogues, and options for more efficient work in the reading rooms.

Smart technology for smart education. Use of internet technologies allows students not only to help in their adaptation to university life, but is also conducive to their mastering of subjects through expanding the course content, teaching, and learning methods. In addition, it increases students' motivation to learn and provides them with opportunities to study independently and acquire radically new knowledge that would be of practical importance in their future workplace. Guidance counselors are given unlimited opportunities for self-development, which, in its turn, shifts teaching process to a much higher level. It is well known [29] that group methods, which include training sessions, discussions, etc., are key

to effective group work. This activity aims to develop such skills as teamwork, readiness as the leader of the group to formulate team goals, to demonstrate the importance of their future profession, etc. The cognitive process in the training sessions relies on active work by the participants and their own experience. The trainer can assist in acquainting participants with each other, creating an atmosphere of cooperative work, partnership, and mutual understanding. The interactive educational technologies allow students to assimilate new knowledge more effectively and to obtain more information owing to the opportunity to ask questions, express their opinions, practice new skills, etc. Let us consider some forms of training and their purposes:

- "Student Team Building"—communicative skills training, which aims to create a cohesive team in a student group and includes three sessions: "Making introductions," "Group logo," and "Development of group rules and regulations";
- "Time Management"—students learn techniques enabling them to use their time in accordance with their personal goals and values;
- "Stress Management"—students learn the causes of stress; physiological, emotional, cognitive and behavioral symptoms of stress; methods of coping with stress; and examine how to avoid negative impacts of stressors;
- "Conflict and Reconciliation Behavior"—students learn conflict management techniques and develop negotiation skills necessary for effective conflict management; and
- "SMART goals"—students examine the principles of goal setting and forming a personal life program.

According to a survey among students, 32% of them frequently use skills acquired during training and 46% use the skills occasionally. In addition, 8% of students plan to, in the future, use knowledge and experience gained through their training. Webinars are a modern and accessible learning method via the Internet, which are now used as an integral part of the educational process at various levels. Without leaving the office or home, students are able to attend lectures, workshops, or seminars as well as participate in the discussion of topical issues. As mentioned above, the Adaptation Course runs only over two semesters; however, continuity and regularity are vital in student guidance counseling as second-year students are also still in need of support. Therefore, seminars, lectures, and training sessions can be offered using webinar technology. Webinar platforms provide both web-streaming audio and phone-bridge options, yet a survey conducted in 2015 among the students of the Institute of Power Engineering found that 76% of students prefer personal participation in training sessions. Also, 23% noted that they were interested in online training sessions only if it was impossible to attend the classroom.

Resources for smart education. At TPU, modern electronic educational resources have been designed and introduced including software, interactive electronic documents, media resources, and educational complexes. All of these

resources can be uploaded to an online Learning Management System platform to provide centralized management of the educational services. At TPU's Institute of Power Engineering, an online educational resource for guidance counselors has been designed, which includes both interactive electronic documents and an educational complex. The resource comprises the weblog "Guidance Counseling" and the electronic course book "Communication training for the Adaptation Course classes." The personal weblog "Guidance Counseling" was designed by the senior guidance counselor and consists of brief records, which are regularly added to in reverse chronological order and include educational materials, media resources, and presentations. The resources in the blog are available for all TPU guidance counselors. The structure of the blog records resembles the familiar sequential structure of a log and comprises the following pages:

- "Main page"—information on upcoming events for the guidance counselors concerned;
- "Guidance and Counseling History"—history of guidance counseling at TPU;
- "Documents"—resources for performance: the TPU Statement on Guidance and Counseling, schedule, guidelines and work plan templates for "Adaptation Program" courses;
- "Presentations"—an extensive list of presentations, from which a guidance counselor can choose the relevant one for his/her class;
- "Video"—videos for in-class activities and different video training sessions for faculty;
- "Tests and Questionnaires"—tests and questionnaires designed for the counselors to consolidate their expertise or to evaluate their level of knowledge for further professional development;
- "Wall"—a feature making it possible for counselors to exchange their opinions on different topics; and
- "Electronic manual"—where the electronic course book "Communication training: in-class application" is posted.

A blog as a means of network communication has a number of advantages in comparison to web forums, chats, and email. A blog reader receives information and feels that he or she is a part of the counseling community. The latter is a result of the guidance counselor being informed about the events held at the university and knowing colleagues' attitudes to the activities performed by other guidance counselors. Additionally, a blog guest can make comments or participate in a discussion with the blogger if the blogger agrees to such a mode of communication.

A poll conducted in 2014 among the guidance counselors of the Institute of Power Engineering found that approximately 30% of them considered the Adaptation Course classes difficult to teach. This was the reason for the development of training materials as well as an electronic course book. The goal of the electronic course book is to develop skills and knowledge for guidance counseling. After studying the e-course book, a teacher is supposed to: know what a training session is; be capable of using training plan templates and scenarios; gain

experience in designing training session scenarios; and be able to hold a training session within a class. In terms of the structure, the electronic course book is based on three modules: introduction, basic information, and workshop and testing.

The advantages of using an electronic course book are having an advanced, user-friendly and sufficiently simple navigation mechanism within the tutorial; optimization of user interface adaptation of educational material to the level of students' knowledge; inclusion of multimedia fragments (graphics, audio, and video); and adaptive user interaction with the elements of the course book.

Peer guidance. Within many Russian higher education institutions, there are student organizations charged with helping freshmen to adapt to university life, so-called "peer guidance." Such a project was launched at TPU in 2013 with a clear structure, strategic objectives, and feasible techniques. It is successfully developing thanks to students' active support.

The main objective of peer guidance is the educational and social adaptation of first-year students to the university environment, as well as to student life, by contributing to the personal development of the freshmen. To ensure successful implementation of the "Peer Guidance" project, students have designed an information and communication website on the social network "Vkontakte". The website is maintained by a student-guide under the supervision of the Senior Guidance Counselor of the Institute and a psychologist in charge of the University Centre of Personal Development. They post records, photos, and video films on the varied events organized and held by students. It allows students and guidance counselors to exchange information on their experiences, compete in their achievements, and prepare an annual report, which is presented at the Guidance and Counseling Service.

The main advantage of peer guidance is that it was created for voluntary participation, based on the personal motivation of each student-counselor. Thus, the student-counselor becomes a mentor for first-year students, whom they trust, who guides them, and whose opinion is important for them. A student-counselor not only plays an important role in first-year students' lives, but also helps and contributes to the development of their competencies. Thus, guidance counseling acquires a new form and extends the capability of its activities, becoming part of the smart environment.

12.5 Testing of Research Outcomes

This educational model was tested at the Department of Electrical Power Systems at TPU in cooperation with the Department of Higher Mathematics. Students are taught disciplines supported by e-courses in LMS Moodle. In addition, first- and second-year students are offered uncomplicated mathematical problems related to power engineering. Third-year students study the professional discipline "Power Plants" in Russian in the fall semester and in English in the spring semester. Masters' students are taught in collaboration with experts from local power industry companies.

12.5.1 Issues in e-Learning

The web-based portions of the courses aim to develop students' independent learning and assess the outcomes. The effectiveness of web-courses is monitored annually. The online surveys were conducted at the beginning and end of each semester and involved 546 students. The following aspects were analyzed: (a) course site design and attractiveness; (b) student perception of online learning; (c) benefit from the course; (d) prompt and timely feedback. The majority of students consider teacher online feedback "important" and "very important" (Fig. 12.3).

The solid line represents courses in general, whereas the dashed line represents theoretical courses only [22]. Figure 12.3 shows that face-to-face communication is of extreme importance for theoretical disciplines such as mathematics.

Online consultation in particular does not seem to be an appropriate way for explaining some difficulties faced in problem solving. In our opinion, mathematics requires not only verbal contact for better explanation, but also face-to-face communication. Better results would be achieved by the personal involvement of students in problem solving. Mathematics becomes clear and understandable through watching the progress of solving problems on a board or on a piece of paper. Therefore, some massive open online courses (MOOC) teach mathematics (for example, at the University of Ohio) using simulation of a "sheet of paper and pencil." E-learning and b-learning allow not only student-teacher communication, but also student-student communication. Figure 12.4 also shows students' opinions on the ability to communicate online with their fellow students. The prevailing character of social networks could explain the low percentage.

Additionally, students noted some benefits of web-courses. Figure 12.5 shows the students' opinion of the possibility of increasing their rankings and constant access to teaching aids (dashed line—Higher Mathematics, solid line—Power Plants).

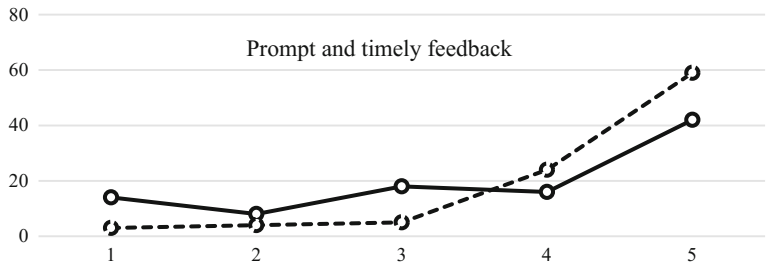

Fig. 12.3 Percentage distribution of responses of students from 1—"not important" to 5—"very important"

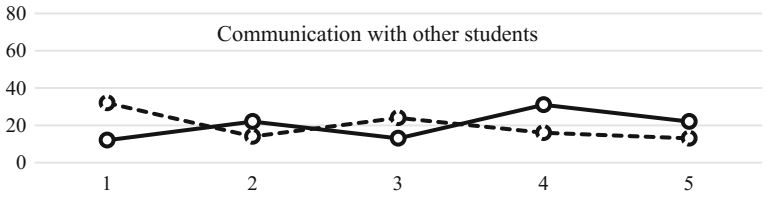

Fig. 12.4 Percentage distribution of responses of students from 1—"not important" to 5—"very important"

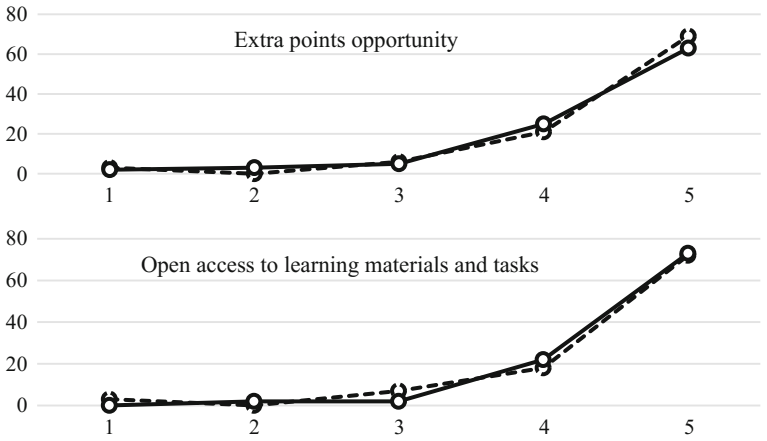

Fig. 12.5 Percentage distribution of responses of students from 1—"not important" to 5—"very important"

12.5.2 Student Perceptions on the Relevance of Course Components

A comparative analysis of the relevance of web-course components was carried out. The survey findings indicate that intensity of content requests was greater when students were involved in creating content. Figure 12.6 shows the statistics of visits to web-courses (dashed line—Higher Mathematics, solid line—Power Plants). As seen in Fig. 12.6, the majority of freshmen start to use the electronic part of the math course intensively just before the exam (dashed line). Moreover, the most popular items during this period are different tests.

However, senior students use the web-course more evenly throughout the semester (solid line). This can be explained by the fact that the professional disciplines involve innovative smart technology more frequently. For instance, the discipline "Power Plants" was supported by two web-courses in Russian and English. The Russian version consists of tests, forums, videos, teaching aids, etc. It

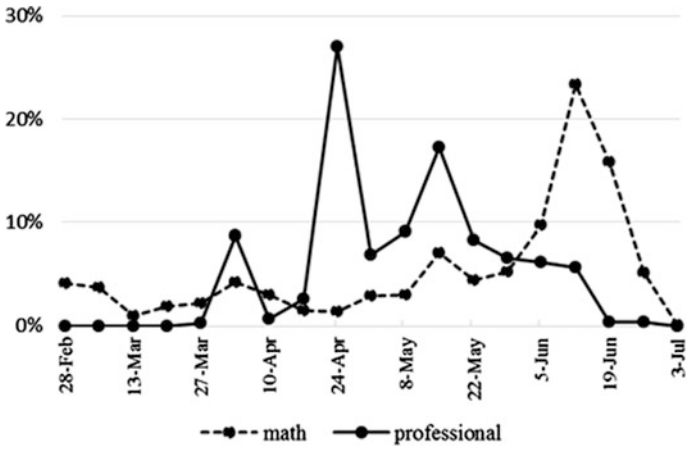

Fig. 12.6 Distribution of the intensity of use of web-courses during the semester

should be noted that students, while under instructor supervision, created the theoretical portion of the content. After discussion in the classroom, the best presentations were downloaded. It was observed that co-created content is required by students of other groups as well. At the end of the semester, an anonymous survey was conducted in order to analyze the effectiveness of this approach. The results are shown in Table 12.3.

It was observed that the "role reversal" method forces students to use different resources (books, the Internet, scientific papers, etc.) in order to find relevant information. They even visited the websites of manufacturers of the required equipment. The English version's content aims to enhance intrinsic motivation for studying professional disciplines in a foreign language. The web-course consists of scientific papers, video materials, tests, a glossary, etc.

Table 12.3 Students' opinions on the "role reversal" method of education

Questions	Yes, %	No, %
Was it your first experience of presenting a new topic for your fellow students?	100	0
Was the topic of your presentation interesting for you?	90	10
Was it challenging to choose the exact piece of information concerning your topic?	75	25
Was it challenging to organize and adapt the material for your presentation?	80	20
Were your fellow students' presentations clear and understandable?	89	11
Do you find this way of new knowledge acquisition useful and promising?	94	6
Would you like this methodology to spread to other disciplines?	90	10

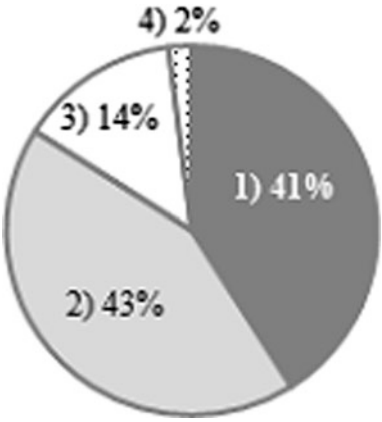

Fig. 12.7 Bachelors and masters' students on studying the "Power Plants" discipline in English

Only authentic materials are used in the web-course. Teachers and students both emphasized the significant role of the course in professional English training. Figure 12.7 shows the survey results on how bachelors and masters' students assess the necessity of using English in their professional activities.

Figure 12.7 shows that the main driving force for studying the subjects in English is:

1 the teacher demonstrates his/her proficiency in English (41%);
2 general knowledge of English (43%);
3 discipline and interest in the subject (14%); and
4 other variables (2%).

12.5.3 Providing Support for Students

The Institute of Power Engineering carried out a survey to learn the opinions of students about the guidance and counseling service. The survey involved 243 students (174 first-year and 69 second-year students). The students were asked to evaluate various aspects of the guidance counselors' performance. Overall, about 90% of respondents assessed the work as "good" and "excellent." Figure 12.8 shows the assessments on a 5-point scale: 5—"excellent"; 4—"good"; 3—"improvement needed"; 2—"bad"; 1—"very bad."

The statistics show that not all the students were satisfied with the performance of the guidance counselors. This could be explained by the fact that an academic group usually consists of 20–25 students and a guidance counselor is not able to focus on such a large number of individuals. We suggest that one guidance counselor support only 10–15 students. Nevertheless, the experience of involving senior students in guidance counseling showed good results.

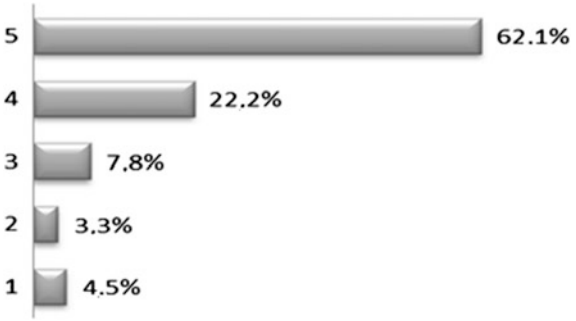

Fig. 12.8 Assessment of guidance counselor support in adaptation to university life

12.6 Discussion

As mentioned in the previous sections, smart education is a new evolutionary paradigm in education with huge capacity for the development and creativity of all participants of the educational process. Focusing only on two main aspects of smart education—independent and lifelong learning—we became convinced of the effectiveness of this approach in comparison to traditional education. In addition, we saw an immediate positive student reaction to such smart components as web-courses, smart boards, web labs, training sessions, etc.

Figure 12.9 shows what kind of training students find more useful and interesting. As can be seen from the diagram, at the beginning just over half of the students were in favor of a blended form. However, after graduation, about 70% of students prefer a blended approach. This agrees well with the results in [18].

The effectiveness of the proposed methods for introducing smart technologies in students' independent work was evaluated. The evaluation has shown a positive tendency in the development of independent learning skills. However, the analysis has shown that intrinsic motivation is too low to achieve 100% effectiveness of the proposed methods for the organization of independent and lifelong learning. This

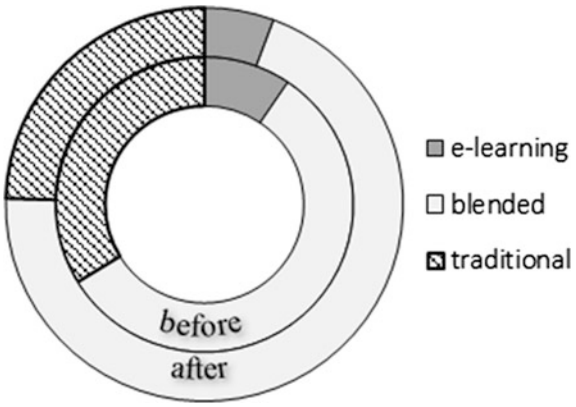

Fig. 12.9 The answers to the question: which form of study would you prefer?

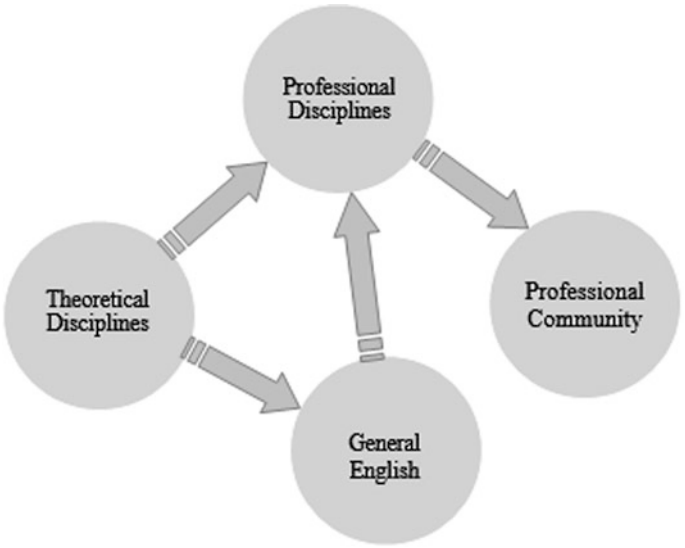

Fig. 12.10 Model A: traditional scheme

can be explained by the fact that we are taking the first steps in this direction as well as by the relative overload of students.

At present, it is not always easy to involve professional communities in the educational process. This approach has been implemented now only in one group of undergraduates due to the heavy workload of professionals. Initially, the university made use only of a traditional model, where the main components (theoretical disciplines, professional disciplines, English language and the professional community) did not overlap in the educational environment, i.e., they influenced each other, but without collaborative educational content (Model A) (Fig. 12.10).

Adding "Power Stations (in English)" to the curriculum, the area of overlapping is formed naturally and depicted as a common content of disciplines "Power Stations" and "General English" (Model B) (Fig. 12.11).

At present, the example of involving professional communities in undergraduate education led to a scheme in which the content of professional disciplines and professional communities overlaps (Model C) (Fig. 12.12).

In the future, the development of smart education and smart technologies ought to lead to the overlapping of theoretical disciplines, general English, professional disciplines, and the professional community in a smart educational environment (Model D) (Fig. 12.13).

Fig. 12.11 Model B: traditional scheme including professional English

Fig. 12.12 Model C: traditional scheme involving the professional community

Fig. 12.13 Model D: smart educational scheme

12.7 Conclusion

This paper examines some techniques aimed at enhancing student motivation in terms of independent work and in relation to independent and lifelong learning. The following means were considered:

- A "role reversal" method of education;
- Professional training in English;
- Involvement of the professional community in the educational process;
- e-Learning and b-Learning.

The above techniques were first designed independently by the faculty of different departments involved in teaching power engineering at Tomsk Polytechnic University. A powerful trend toward a united effort to combine forces, techniques, and experience in teaching the disciplines "Higher Mathematics," "Power Stations," and "Power Stations (in English)" enabled us to discover common issues and approaches to their solution.

The review of existing literature on the introduction of smart technologies in higher education demonstrates its current relevance. The introduction of smart technology makes the educational process much more interesting and helps to develop the latent potential of students. It is expected that it will lead to improved results in the training of professionals, which in turn requires teachers to have a high degree of competency in using smart technology [30]. Analysis of the proposed methods showed that the application of smart technologies to the independent work of students (LMS Moodle) leads to higher results in the learning of both theoretical and professional disciplines; however, professional and theoretical disciplines do not presently have common content in the smart environment. This study marks the beginning of the formation of a new curriculum aimed at a fusion of disciplines in all cycles of academic and vocational education—the creation of a system of smart education.

We began with the creation of overlapping smart content for the subjects "Higher Mathematics" and "Power Plants". Further analysis needs to be conducted to evaluate the results of the introduction of combined smart content to the educational process. Naturally, the first results may be obtained after at least four years when the students complete studying both the theoretical and professional disciplines. In the future, it is expected that the introduction of such an approach will lead to increased motivation in relation to independent learning and lifelong learning. This is achievable owing to students forming the essential skills of independent work while searching for new information and finding solutions to new problems. In addition, these graduates will be capable of making use of international practices and ideas.

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