UDC 37.022; 53

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Didactic Conditions of Industrialization Risk Mitigation in Engineering Education

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Received: 12.03.2017 / Accepted: 06.12.2017 / Published online: 31.12.2017

Abstract

The article deals with the issue of engineering education industrialization. The risks of engineering education industrialization are identified. The didactic conditions of their mitigation are grounded: arrangement and management of a student's autonomous work with possessed information (textbook) and raw information (research engineering data).

Key words: didactic conditions, engineering education industrialization, autonomous work, textbook.

The history of engineering education in Russia is closely connected with the history of economic transformations in the country. In a time of transition to innovative economy, the Russian economy suffers from the lack of engineering personnel. That reasons are:

First, training of engineering staff does not correspond to economic growth. Only 27,6% of university students are trained in engineering specialities.

Second, students have the right to acquire professional knowledge and skills relevant by the time of graduation from a university. Today, by graduation from university a graduate has 90% of outdated knowledge as the knowledge update rate is 15% per a year [1].

The demand for engineering personnel defines a general goal for engineering education – development of breakthrough technologies, training of demanded personnel for industries [2].

Educational reforms always addressed the challenges of economic development and encouraged new challenges. At present, the key contradiction is a discrepancy between graduates' professional competencies and growing demands of high-tech enterprises, design and scientific institutions. To provide competitive advantage for the Russian economy means to make a technological leap forward. To make the technological leap means to industrialize engineering education. Russian engineering education has some experience in industrialization of training: in the period of planned economy from the 1930's to the transition of Russia to market economy in the 1990's the engineering education was tightly connected with industry and science. Taking into account the advantages and disadvantages of previous experience from the 00's of the 21-st century, under the condition of transition to innovative economy industrialization of engineering education was performed through education corporation of "science – education – production plus innovation" system. Hence, the task of university teacher is to provide dialectic development of education corporation as a system, the driving force of which is a science.

We have revealed possible risks of education development:

Risk 1. Instead of demanded engineering personnel the real economy of Russia could have a functionally illiterate graduate of engineering university without fundamental (natural science) constituent of engineering training. For the students learning at engineering universities physics is a basis for mastering technical courses. According to the Educational Standards of the Federal State Educational Standard for Higher Education (HE FSES) curriculum guidelines are developed. On average from 9 to 12 credits of total credit number are provided in the curriculum guidelines for physics course depending on Bachelor specialization. In this way, the curriculum guidelines correspond to the minimum workload. The minimum workload implies students' ability to reproduce typical situations, use them for solving the simplest problems [3]. In contrast, the previous curriculum was close to a basic level in terms of workload. It assigned 500-550 hours (15 credits) on average. Comparative analysis of existing curricula has led us to the conclusion: new curriculum guidelines on physics initially include the trend for reduction of Bachelors' knowledge quality in future.

Risk 2. Instead of demanded engineering personnel the real economy of the country could have a functionally illiterate graduate of engineering university without teaching first-year students to learn independently. Students' autonomous work is one of the conditions for students' training that would give a teacher the possibility to compensate that small number of classroom hours assigned for learning physics at an engineering university. Until the mid-90's of the 20-th century the previous curriculum provided 53% of total learning time for students' classroom activity with a teacher. Independent work was divided into classroom independent work under a teacher's supervision (13%) and autonomous work (34%). Classroom work was the main form of learning activity and took approximately two thirds of student learning time. Starting from the 00's of the 21-st century, students' independent workload assigned by the HE FSES of the second generation increased in percentage of workload for learning a course. Today, this share is 50 %, of which more than 90 % are autonomous work done without a teacher. The instructive letter "On intensification of students' autonomous work in higher institutions" recommends increasing its share up to 60-70 % more [4]. Hence, if independent work at school "is largely limited to home assignment consisting of exercises similar to those done in class" (V.L. Kraynik) [5, p. 54], a significant part of learning material on physics at university can be studied by first-year students autonomously.

From O. Vasilyeva's speech, the Ministry for Education and Science of Russia in mass media: no university should lower the threshold of Unified State Exam (USE) score less than 60 points. It means that universities are to enroll only those who are able to learn there. However, only small percentage of pupils can pass physics exam. In the condition of demographic pitfall, low USE score on physics gives students the right to be a student of engineering university. To identify first-year students' readiness for learning physics autonomously with "declining" assistance of a teacher, let us consider the outcomes of diagnostic test on physics centrally performed at Tyumen Industrial University [6].

The histogram of distribution density of testing outcomes allows estimating the character of test outcome distribution and students' division into preparation levels. It also allows revealing that:

1. Less than 20% of the first-year students are able to learn information independently.

2. More than 80% cannot master physics independently even at minimal level of workload and need teacher's assistance.

The analysis of placement test outcomes has brought us to the conclusion:

1. It is necessary for physics teachers to take into account the knowledge level of each first-year student for learning university course of physics.

2. It is enough to organize and manage the autonomous simultaneous work of 80% students with processed information (textbook) and 20% students with raw information (research engineering data).

In the period of global informatization, the demand for acquiring increased amount of unprocessed information contradicts to time limitation intended for learning unprocessed information in the classroom. In this context the issue of organization and management of students' autonomous work with processed information (textbook) and raw information (research engineering data) is becoming rather urgent.

The concept "autonomous work" is a multi-component and complicated phenomenon. Under students' autonomous work we mean work arranged and done by the student him/herself both without direct and indirect supervision of a teacher under the condition of a student's readiness for independent learning. To achieve the goal of training student ready for autonomous work with processed and unprocessed information, we used systematic and scenario-based research methods. A system is considered as a means of problem solution, whereas scenario-based approach is focused on studying a definite situation and developing a system based on it that meets specific conditions and requirements [7].

There is no single way of organization (the key statement of scenario-based approach), but there are different types of organization system defined by needs, development level, and interaction with the environment. It means that structure of autonomous work of 20% (Group A) and 80% (Group B) of first-year students with physics textbook is to meet the demand and knowledge level of students from each group and a particular student as well as their interaction with the information environment.

One particular student has to consider autonomous physics learning with textbook as autonomous work to develop a skill of comparing the account of the same issues in different sources, expressing his/her own opinion. The main task of a student is to learn independent thinking within a year or a year and a half. "Nobody can teach us think independently, if you don't want to do this by yourself" (P.L. Kapitsa) [8, p. 9]. Every student interprets and perceives physics differently. "Different authors design textbooks on general physics presenting the subject in a way, which is familiar for them. You should select a textbook, which is mostly to your liking" (P.L. Kapitsa) [ibid, p. 7]. It should be a textbook, whose author thinks in the same way as does the student who learns physics with individual textbook. It means that one particular student can understand only that textbook, which was developed by him/her.

We have developed a model of student-centered successive textbook on physics. The student-centered successive textbook serves as an example of students' independent work with physics textbook at the lecture and self-training after lecture. Student-centered successive textbook means here a structured textbook consisting of separate textbooks: basic, successive, and student-centered. Textbooks, in their turn, consist of separate modules. These modules are combined into a thematic cluster [9].

Structural-functional design of student-oriented successive textbook on physics serves as a framework for organization of students' autonomous work with processed information (physics textbook) with a "declining" teacher's assistance [10].

Let us consider implementation of organization framework of the students' autonomous work based on the scheme of developed model without preparatory reading of training text with the set limits: duration – 210 min, venue – classroom, materials – in electronic and printed format, aids – physics textbook and mobile phone (Table 1).

We use the suggested framework (structural-functional model of student-oriented successive textbook on physics) of organizing students' autonomous work with physics textbook as a scheme, by means of which we can develop a new models of students' autonomous work with processed information (textbook) and raw information (research engineering data). The model is a relatively fixed structure, whose stability is maintained by limitation for the autonomous work of this type.

Table. 1. Structural elements of classes and student's activity with training text in the classroom

Structural elements of classes	**Student's activity with training text**	**Student's activity with training text "Electrostatics" [11, p. 160-167]**
At the classes		
At the lectures		
Stage I. Identification of students' knowledge and reading competence on the study theme: 1. Lecture task setting: a) knowledge updating;	A student works with a text given by a teacher independently, reads the necessary chapters to search for the main idea. He/she looks for the answer to the question: what is this text about? The main idea of a training text most often coincides with the title of chapter. He/she updated the background knowledge on the study text to find the answer for the question: what do I know about it? He/she prepares for new knowledge.	Dielectrics in the field. *I know:* 1. Dielectrics. Types of dielectrics. 2. Polarization of dielectrics. Forms of polarization. *I can* classify dielectrics. At this stage a student updates his/her knowledge, namely, his/her activity focuses on filling in the gaps in school training on the theme "Dielectrics in the field". The conditions for mastering the topic of the university course are created.
b) student's motivation;	A student looks through the main text in the chapter. A student needs to achieve the goal: to update and extend the knowledge and wants to acquire new knowledge.	
в) identification of knowledge to be taught.	A student identifies new knowledge that is to be learnt. New knowledge of the training text most often coincides with the title of paragraph in the textbook. He/she sets the tasks: I want to know... I want to be able to...	*The lecture theme* "Dielectrics in the electrostatic field". *Outline:* 1.Polarization as a physical phenomenon. 2. Physical magnitudes characterizing polarization: polarity, voltage of electrostatic field, displacement vector, dielectric susceptibility, dielectric permittivity. 3. Physical laws of polarization: Gauss theorem of electrostatic field in dielectric, the law of line refraction and electric flux lines, Coulomb's law.

Structural elements of classes	**Student's activity with training text**	**Student's activity with training text "Electrostatics" [11, p. 160-167]**
2. Theme and outline of a lecture.	Students together with a teacher state the theme of a lecture. The lecture theme coincides with the main idea of the training text in general. They compose the outline of lecture. The items of lecture outline most often coincides with the titles of paragraphs of the textbook.	*The lecture theme* "Dielectrics in the electrostatic field". *Outline:* 1.Polarization as a physical phenomenon. 2. Physical magnitudes characterizing polarization: polarity, voltage of electrostatic field, displacement vector, dielectric susceptibility, dielectric permittivity. 3. Physical laws of polarization: Gauss theorem of electrostatic field in dielectric, the law of line refraction and electric flux lines, Coulomb's law.
Stage II. Mastering new knowledge: 1. Learning and initial mastering new knowledge.	A student makes notes of a lecture. A lecturer divides the lecture content into semantic parts. After delivering each part lecturer arranges discussion according to the generalized outline of structural elements. When mastering new knowledge, a student reads the main text of the textbook paragraph to find the answer for the question: what is said about main idea in the paragraph? From the initial mastering of new knowledge – to extra-textual component of the textbook paragraph. A student makes exercises to initially master new knowledge. He/she adjusts mastering new knowledge, corrects the lecture notes.	
2. New knowledge reinforcement.	A student solves a training problem. When mastering new knowledge, a student turns to the extra-textual component of the textbook chapter. He/she does the tasks for secondary mastering of the known new knowledge. He/she adjusts new knowledge secondarily. He corrects the lecture notes.	

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Structural elements of classes	**Student's activity with training text**	**Student's activity with training text "Electrostatics" [11, p. 160-167]**
3. New knowledge assessment.	A student thinks over the new knowledge. A student turns to the main text of the textbook chapter. He/she corrects the lecture notes.	
At the classes		
Complex application of new knowledge.	A student solves a training problem. I know and be able to do the tasks: 1) of complex application of new knowledge: a) in familiar situation, b) unknown situation, c) to transfer the knowledge into new condition; 2) of generalizing and systematizing new knowledge. He/she adjusts the new knowledge.	
At the lab work		
Complex application of new knowledge.	A student solves an experimental training problem. I know and be able to do lab work.	

In conclusion, student-oriented module of structured textbook is, firstly, a result of one particular student's autonomous work with processed and raw information; secondly, a student's development trajectory as an element of "science – education – production plus innovation" system.

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UDC 656.13: 51.74

The 50th Anniversary of VAZ: Higher Education in Togliatti as an Indicator of Innovative Development for PJSC "AVTOVAZ"

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Received: 28.09.2017 / Accepted: 04.12.2017 / Published online: 31.12.2017

Abstract

The Volga Automobile Factory and Togliatti State University (TSU) were simultaneously founded. The development of both institutions was conditioned by mutual interaction in a number of aspects including scientific and research ones. The university contributed to the technical, technological and innovative solutions applied at the factory. It is also TSU that provided engineering staff for the factory. The modern condition of higher education in TSU reflects the same situation in PJSC "AVTOVAZ", that is system crises in science and production. Both institutions have the same objective and subjective problems: the lack of funding for research, the cut of engineering structures (departments) at the factory, the decrease in university science activity, staff shortage, and subjective decisions made by top managers.

Key words: history of development, higher education, automotive industry, PJSC "AVTOVAZ", staff training, innovative development, social and economic situation, "WSET" department, TSU, joint projects, engineering, university science, problems in funding.

Interconnection between science and production is the key factor in any industrial branch and the entire regional economy. The failure of such relationships leads to decline both in higher education system and production. The current state of interaction between Togliatti State University (TSU) and VAZ (Togliatti) causes worries about the regional economic development. Thus, the aim of the research is to analyze the interaction of the departments that are parallel to each other in TSU and VAZ both from a historical perspective and current status.

The development of VAZ is closely connected with the development of higher education system in Togliatti, in particular Togliatti Polytechnic Institute (now Togliatti State University). These two institutions had a parallel development and influenced each other in the spheres of education, science and innovation. The history of TSU, in its turn, is closely connected with the department "Welding and Soldering Equipment and Technology" (WSET) (now the department "Welding, Fabrication and Allied Processes"). Currently, it is one of the leading departments providing engineering training in TSU and the only department in Samara region that provides training in welding and soldering fabrication. B.E. Paton, G.A. Nikolaev, and N.N. Rykalin, the members of the Academy of Science of USSR, made a significant contribution to the WSET development. They supported scientific schools and research in developing technology for three-phase arc deposition and welding (the director was V.I. Stolbov).