

The Peculiarities of Training Bachelors of Engineering in the Classical University

A. Popova

Chelyabinsk, Russia
popovaaa@rumbler.ru

E. Chyornaya

Institute of Economics of industries, business and
administration
Chelyabinsk State University
Chelyabinsk, Russia
echernay@mail.ru

Abstract— Polytechnic education is becoming very significant for the Russian educational system nowadays. It provides training of the engineers capable of using knowledge from various areas, both technical and humanitarian. In this regard, classical universities actively enroll students in engineering specialties. Thus the training programme for bachelors of engineering at the Chelyabinsk State University called 'Quality management in production technological systems' is rather new for both the South Ural school leavers and the labour market. In the course of training students gain the professional competences, which allow them to develop, serve and estimate a quality management system; to analyze business processes, to increase their technological effectiveness and safety.

The article describes the peculiarities of bachelors of engineering training in the classical university at the present stage. The theoretical and practical aspects of students' training in the disciplines of informational cycle are analysed in the present paper. There have been revealed the drawbacks of information cycle disciplines mastering and their causes. The system of special tasks created by the author and based on the principles of intersubject integration, communication and team work is offered and tested. It is aimed at eliminating the previous drawbacks. The methods of content analysis, statistical analysis are used in the research. The study base is the full-time students-bachelors of the Chelyabinsk State University training for the degree 'Quality management'.

Keywords— *information technologies, polytechnic education, competences, intersubject integration, motivation.*

I. INTRODUCTION

The education plays a crucial part the in economic development of our country. The polytechnic education is of great importance nowadays. The merge of different sciences is required to achieve the economic breakthrough that is necessary for Russia. The engineers acquiring knowledge from various areas, both technical and humanitarian are to implement it. In the late nineties academician P.R. Atutov stood up for 'the genuine integration of education, science and production' [2], as he considered that 'in the conditions of global introduction of the machines to all the spheres of human activities', pupils were to study not only the principles of development of the nature and society, but also the principles of development of modern production [3].

The distinctive feature of Russian classical universities was the training of intellectual elite of the country. It means that such institutes of higher education generally didn't prepare the staff for the sector of industry. The challenges of modern industrial development have changed the views on students' training in classical universities. The significance of polytechnic education has brought classical universities to pay their attention to it. Such universities began to create engineering training programmes. So the training programme of bachelors of engineering at the Chelyabinsk State University called 'Quality management in production technological systems' is rather new for both the South Ural school leavers and the labour market. In the present paper, within the frameworks of modern educational standards, we define the bachelor of engineering as a person who has a technical education and has graduated from the classical university with the lowest scientific degree [8].

The article studies the peculiarities of bachelors of engineering training in the classical university at the present time. The ability to solve up-to-date problems concerning the professional activities is directly connected with the mastering of information technologies. Therefore, our attention has been paid to the analysis of theoretical and practical aspects of information training programmes for students.

II. REVIEW OF LITERATURE

According to the bibliographic analysis nowadays staff scientists and experts of universities and colleges all around the world pay much attention to the questions of acquiring competencies in the sphere of information technologies, use of object and process modeling and also didactic aspects of information technologies studies.

At the Tomsk Polytechnic University the development of innovative education is connected with a complex of competences, 'including fundamental and technical knowledge, abilities to analyze and solve problems with the use of cross-disciplinary approach, awareness of methods of design management, willingness for communication and team work' [16].

Agne Brilingaite, Linas Bukauskas, Anita Jusk developed 'problem educational projects' and also the techniques of competence assessment in these projects [5].

The integration of the training technologies was studied by Kumar S., Daniel B.K. While investigating the factors that prevent the introduction of IT (informational technologies), the authors addressed social and psychological aspects (the attitude towards technologies, understanding the effectiveness of IT in the process of training) [14].

Ir. Ushatikova, A. Rakhmanova, V. Kireev, A. Chernykh, M. Ivanov in 'Pedagogical Bases of Formation of Key Information Technology Competencies Polytechnic Institute Graduates' have identified the necessary 'didactic conditions of formation of key information technology competencies by means of new information technologies' [22].

Li, X., Shen, G.Q., Wu, P., Fan, H., Wu, H., Teng, Y. developed 'an advanced simulation game which simulates the process ... from manufacturing and logistics to the on-site assembly by integrating an RFID-enabled BIM platform with lean construction into training students and practitioners' [15]. The work of A. Shymchenko, V. Tereshchenko, Y. Ryabov, S. Salkutsan, A. Borovkov also deals with 'numerical modeling as the most effective, flexible and cheap method for assessment of the level of optimality and viability of the proposed solution and also for forecasting the further life cycle of a product' [18].

The scientific research by Maria Assumpcio Rafart Serra, Andrea Bikfalvi, Josep Soler Maso, Ferran Prados Carrasco, Jordi Poch Garcia 'Improving the learning experience of business subjects in Engineering studies using automatic spreadsheet correctors' states that 'we should train engineers able to combine disciplines - that are each time more specialized - with a variety of interdisciplinary knowledge (like business, information systems, etc.) that could further permit a fluid communication with their work» [17].

A. Abramovich [1], M. Gureev dealt with the problems of training material development for the higher school [12]. O. Bogoslovskaya studied the motivation of receiving the higher education while choosing the profession [4].

Thus, alongside with the studying special information technologies the researchers pay attention to some aspects of methodology of information and communication technologies, and to social and pedagogical aspects of formation of such knowledge.

III. ASPECTS OF TRADITIONAL TRAINING

In order to achieve the target goal (to detect the peculiarities of bachelors of engineering training in the classical Russian university), at first we addressed the Russian educational standards, curricula of the discipline 'Quality management', the contents of the disciplines that study information systems and technologies.

Learning the basis of information systems allows the students to 'work in coordination with organizational resources, such as people, technical means and financial resources' [11] that stock up and distribute information. Studying such disciplines as 'Modern information systems and technologies', 'Information technologies in quality management', 'Engineering and computer graphics', 'Database management systems' future bachelors of engineering acquire the complex of information competences necessary for their professional activities. They study obligatory disciplines of information cycle for two academic years. During this period of time students gain theoretical knowledge and skills necessary for the following competencies: 'ability to solve standard problems of professional activities on the basis of information culture applying informational and communication technologies and taking into account the main requirements of information security'; 'to work with basic applied software and information technologies used in the sphere of professional activities' [8].

Information courses consist of traditional theoretical courses and practical tasks. Carrying out such exercises students get acquainted with the main methods, ways and means of gaining, storing and processing of information; tasks on generalization, analysis and perception of information, goal setting and ways of its achievement; they get some computer skills and study the computer as the means of information management; they work with information in the global computer networks; learn to formulate the goals of their activities correctly, to establish interconnections between them, to build models of systems of tasks, to analyze, diagnose the reasons of problems [8].

The distinctive peculiarity of bachelors of engineering training is a more profound approach in learning management information technologies which is crucial in students' training since the integral part of the graduate's activities is management ones, just because management information technologies are aimed at 'satisfaction of informational needs of each professional taking administrative decisions' [7]. Such technologies are necessary for data processing by special information means. They help to estimate future condition of activities of the object, to give the assessment of deviations of the received result from the planned targets, to identify the reasons for deviations, to analyze possible actions for the correction of deviations.

IV. PROBLEMS OF TRAINING AND THE WAYS OF THEIR CORRECTION

We have studied the results of traditional learning of informational disciplines by the future bachelors of engineering while training for their professional life in order to identify the problems of traditional training. These procedures have shown that there are some difficulties among the students in finding reliable, relevant, full, representative information in various sources, including networks, and also in the analysis and status assessment of an object, in carrying out some

necessary calculations of modern economic problems in one specific region. The discussions with students have revealed different reasons for such difficulties. They are caused by the lack of clear understanding of: 1) aims of learning such discipline as Informational technologies of management and management systems (25%, only girls), 2) connection of these disciplines with other technological disciplines of their training (19%), 3) bases of future professional activities (22%).

These reasons, in our opinion, are connected with low motivation of school leavers and junior students as it is a main constituent of successful training. The improvement of motivation can be achieved by the change of contents of a curriculum, integration of the studying subjects with other disciplines, setting their own goal in the educational process which the student has to achieve himself [13,21]. Considering motivation as a stimulus for the student, we addressed to the works of N.F. Talyzina [19,20] who claimed that the student 'has to realize why he needs the knowledge that is offered to him. Therefore it is necessary to move from motives to targets, and then to contents'. Motives must be the internal incentive force in forming the desire for knowledge. Students' personal motives can be based on some principles connected with the future exploratory activities of the bachelors of engineering.

At first we are going to consider the possible ways of solution of the identified problems. According to N.F. Talyzina's scheme, we analyzed enterprises for future professional activities of students. As a rule, students who finish the Chelyabinsk State University with the qualification 'Quality management' get a job at the enterprises of Chelyabinsk, the Chelyabinsk, Kurgan, Orenburg regions. The largest enterprises of the city, such as iron and steel works, are equipped with the modern informational systems of ERP class, including support subsystems taking administrative decisions in questions of quality management of technological and business processes. In this regard, in order to increase training motivation the following can be used: building relationship with the staff of enterprises, taking part in the discussion of production questions, carrying out work-study tasks which help learning information technologies and management systems. In order to improve the motivation, some groups aimed at studying the quality of production according to student's career orientation, for example, the quality of forestry production, factories, agricultural cooperatives, bread-baking complexes, railroads, the mechanized columns, etc. In such groups colloquiums are targeted and they allow to understand the future professional activities, forming skills of collective work under the supervision of the teacher (professor, the associate professor) and, thereby, bringing into life one principle elaborated by E. Deming who mentioned an important role of cognitive theory in the process of understanding the concepts of continuous improvement. New knowledge constantly changes ideas of an optimal quality level and directs it towards the interests of the consumer [6,9].

Then we turned to the programmes of mastering the disciplines of informational cycle for future bachelors of

engineering who study the disciplines of Quality management and also to the programmes of other disciplines of this profile. The comparative analysis distinguished approximately ten disciplines which could be integrated with the disciplines of informational cycle, these are 'Engineering technologies in the professional activities of an industrial company', 'Innovative management', 'Productive management', 'Statistics', 'Organizational and economic bases of functioning of the industrial enterprises', 'Metrology, standardization and certification', 'General quality management', 'Economic security at the enterprise', 'Strategic management', 'Methods and means of measurement, tests and control'. It allows to introduce necessary changes in the programmes of mastering the disciplines of informational cycle and promotes the introduction of managerial information technologies into the educational process of mastering other disciplines.

In order to increase the level of students' motivation in mastering the disciplines of informational cycle we changed the contents of training material at the expense of integration of the different courses. Mainly, we paid our attention to the contents of practical tasks which are employed in higher education for checking theoretical knowledge of disciplines of informational cycle. Earlier such tasks were aimed at mastering certain basic technologies, but now we offer the system of tasks constructed on the principles of intersubject integration. This system provides clear understanding of the role of computer studies in future professional activities, which increases the level of motivation in training. As a rule, the tasks are problem-plagued, the number of questions increases. Students have to apply the skills received on other disciplines in order to transform production problems into informational ones, i.e. to transfer processes of the physical world to the virtual one. The idea of such tasks is given by the following example.

V. EXAMPLE

Input information:

The studied disciplines of informational cycle: 'Information technology in quality management', 'Database management system'.

The disciplines of integration: 'General quality management', 'Standardization, quality management and metrology', 'Organizational and economic bases of functioning of the industrial enterprises', 'Statistics', 'Mathematical methods of modeling in economy'.

Branch of production (enterprise): JSC Russian Railways

It is given: Functional strategy of JSC 'Russian Railways': 'Development strategy of the market of maintenance of equipment and increase of efficiency of repair activities of the Company (REPAIR)" [10].

General task of the enterprise: To provide parameters of maintenance of equipment quality.

Specific task: To provide replacement of brake pads of the rolling stock, considering service life not less than 50 years. To achieve this, it is necessary:

1) To choose informational technologies to solve the following tasks:

A) application programs of general use (DBMS, text editor, spreadsheet, etc.);

B) the specific software package installed at the enterprise (SAPLOGAN, ESD, etc.);

2) to study the market and to make selection of suitable options;

3) to select according the price/quality/service life ratio.

Performance of the task.

A) Students create the database with the use of MS ACCESS.

At first the group of students investigates the subject domain, therefore they find input information concerning the volume of production that is to be repaired at the enterprise, and also studies the requirements of the state standard. They examine the market, suppliers of products, the price, quality, volume of the products that they emit. Information search includes work with information resources, such as the state standard, 'Transport rules of the railroads of the Russian Federation', duty regulations of the enterprise staff, the review of the manufacturers of targeted production in the region, etc.

Then students reveal objects of the subject domain and establish interconnections between them (create infologic model). The tables are filled with the obtained data during the process of physical designing of the database.

At the following stage there is statistical processing of the obtained data in accordance with the requirements of the customer (for example, by means of MS EXCEL), the optimal variant is chosen (the Search of the Decision tool solves a problem of minimization of expenses providing high quality production and long term of its use). The students create recommendations for the enterprise concerning the purchase of necessary production.

B) Students use an automated control system (for example, SAPLOGAN).

The stage of gaining information from various sources is similar and comes to the end with the decision of whether to make a purchase or not. In such systems the process approach is used, thus the students draw the chart of the process including the following sections: the process purpose, consumers of the process, input details of the process, the head of the process, criteria of process effectiveness, etc. On the basis of this chart students create the purchase order in the program in the Logistics module.

The updated system of tasks constructed on the principles of intersubject integration is aimed at elimination of problems in mastering the competences which are defined in the federal state educational standard of the Russian Federation for this major. The peculiarity of the tasks is complexity of the questions reflecting the essence of management of production technological systems.

Similar tasks have been offered to students who were mastering the disciplines of the informational cycle. After finishing the disciplines students underwent the second survey in order to identify their level of motivation. Many students got an obvious understanding of the importance of mastering

the informational technologies and management systems (92%), interconnections of informational disciplines with other technological disciplines (94%). We have revealed the increase of interest in studying the informational disciplines for the degree of 'Quality management' among bachelors of engineering at a classical university.

Thus, the peculiarities of training of bachelors of engineering for the degree of Quality management at a classical university are characterized by deep mastering of the management of the informational resources, systems and technologies. Modern vision of training for such a degree demands the shift of accents of bachelors of engineering training from the position of simple users of technologies, including informational ones, to the position of managers. While training students gain the professional competences allowing to develop, serve and estimate management system quality; to analyze business processes and increase their technological effectiveness and safety.

References

- [1] Abramovich A., 2016. Main problems of the higher school eyes of the modern student. Yaroslavl pedagogical bulletin, № 1, pp. 302-304.
- [2] Atutov P., 1999. The Concept of polytechnic education in modern conditions. Pedagogics, № 2, pp. 128.
- [3] Atutov P., 1999. Polytechnic education: encyclopedia of professional education: in 2 v., – V. 2. Russian joint stock company: association "Professional education", Moscow.
- [4] Bogoslovskaya O., 2006. Motivation of receiving the higher education in the context of choice of profession, the Higher education in Russia, № 5, pp. 44-47.
- [5] Brilingaite A., Bukauskas Linas, Jusk Anita, 2018. Competency Assessment in Problem-Based Learning Projects of Information Technologies Students. Informatics in Education, Vol. 17 Issue 1, pp. 21-44.
- [6] Deming E. 2007. Recovery from the crisis: A new paradigm of management of people, systems and processes. Translation from English, publishing house «Alpina Business Bucs», Moscow. 620 p.
- [7] Encyclopedia of Economics. Available at: <http://economy-ru.info/info/16276.pdf> [Accessed 01 June 2018].
- [8] Federal state educational standard of higher education / training direction 27.03.02. Quality control. Available at: <http://fgosvo.ru/270302.pdf> [Accessed 20 May 2018].
- [9] Fourteen points of the program of Deminga for management. Diseases and obstacles in a way of transformations, Newsletter of Association Deminga, Moscow, 1993.
- [10] Functional strategy of quality management in JSC "Russian Railways". Available at: http://www.rzd.ru/static/public/ru?STRUCTURE_ID=1448. pdf [Accessed 20 May 2018].
- [11] GOST P ISO 9001-2015 (ISO 9001:2015), Quality management systems - Fundamentals and vocabulary. Available at: <https://catalogue.normdocs.ru/?Type=searchresult&devs=com.normdocs.dict.developer.record.iso&actual=true&yclid=315855979588905240>. pdf [Accessed 20 May 2018].
- [12] Gureev, M., 2012. "Slippery" sides of a modern education system in Russia. Problems of the Higher School, Psychology, sociology and pedagogics, № 5. Available at: <http://psychology.snauka.ru/2012/05/571.pdf> [Accessed 17 April 2018].
- [13] Komarov E., Zhdankin E., 2006. Current trends of motivation and stimulation of personnel, Human resource management, № 23, pp. 67-68.
- [14] Kumar, S., Daniel, B.K., 2016. Integration of learning technologies into teaching within Fijian Polytechnic Institutions, International Journal of

- Educational Technology in Higher education, volume 13, Issue 1, 1 December 2016, number of article 36.
- [15] Li, X., Shen, G.Q., Wu, P., Fan, H., Wu, H., Teng, Y., 2018. RBL-PHP: Simulation of Lean Construction and Information Technologies for Prefabrication Housing Production, *Journal of Management in engineering*, volume 34, Issue 2, 1 March 2018, number of article 04017053.
- [16] Pokholkov Yu., Chudinov V., Solovyov M., Hooks Yu., 2018. The System of elite and innovative education at the Tomsk Polytechnic University. Problems of formation and development, *Online magazine «Basic researches»*, № 1, S. 63-65 (2006). Available at: <http://www.fundamental-research.ru/ru/article/view? Id=4646>. pdf [Accessed 20 April 2018].
- [17] Rafart Serra, M.A., Bikfalvi, A., Masó, J.S., Carrasco, F.P., Garcia, J.P., 2017. Improving the learning experience of business subjects in Engineering studies using automatic spreadsheet correctors, *Journal of Technology and Science Education*, Volume 7, Issue 2, , pp. 203-220.
- [18] Shymchenko, A., Tereshchenko, V., Ryabov, Y., Salkutsan, S., Borovkov, A., 2017. Review of the computational approaches to advanced materials simulation in accordance with modern advanced manufacturing trends *Журнал Materials Physics and mechanics*, volume 32, Issue 3, pp. 328-352.
- [19] Talyzina N., 1998. *Pedagogical psychology, manual for students*, Publishing center "Akademiya", Moscow, 288 p.
- [20] Talyzina N., 1984. *Management of management process of knowledge (psychological bases)*. Mosk publishing house. Un-ta, Moscow. 345 p.
- [21] Tsyppin, BB., Lyukshinov A., Eriashvili Yu., 2006. *Management, manual for higher education institutions*, UNITY-DANA, Moscow, 140 p.
- [22] Ushatikova I., Rakhmanova A., Kireev V., Chernykh A., Ivanov M., 2016. Pedagogical Bases of Formation of Key Information Technology Competencies Polytechnic Institute Graduates, *International Journal of Economics and Financial Issues*, 6(S2) pp. 283-289.