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Team Work for Comprehensive Engineering

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The paper considers the ways to ensure education quality. The principles of creative self-development are described to demonstrate that the psychological function of education, i.e. goal-oriented activity and intentionality, plays an important role in transition from development to self-development. The personality self-development is controlled by the mechanism of emotion regulation and determined by the level of emotional intelligence. The author analyses the assessment criteria for the quality of engineering education provided in higher education institutions in the signatory countries of Washington Accord. The major requirement for engineering student training, which ensures the high quality of education, is to develop the abilities and skills of comprehensive engineering. The authors suggest that leadership skills are the key engineer's competencies to be developed in Russia. The interconnection between comprehensive engineering and leadership skills has been revealed. Also, it has been established that the four abilities and relevant skills included in emotional intelligence (EQ) are essential professional qualities of the leader. The levels of PDLs development have been identified.

Key words: self-development, self-actualization, intelligence, quality of education, psychological function of education.

The main trend in higher technical education improvement is the focus on development of student's individual psychological resources. While developing cognitive function, i.e. transferring scientific knowledge and providing the individual with scientific methods and tools, higher education also fulfils the psychological function – forming the inner world with regard to uniqueness and value of the student's psychological opportunities. It is necessary to develop the competitive specialist training concept on the basis of psychology and pedagogics regularities of formation and development of the personality intellectual qualities. In terms of intellectual development, it means that the training purpose of higher education is not mere learning of academic disciplines, but, first of all, development of students' reflection, ability for self-knowledge, self-management and self-development, broadening and improvement of individual intellectual resources by pedagogical

means. The intrinsic line of this process is to include the students' activities in their self-development processes [1]. V.I. Andreev formulated the basic pedagogical principles of the personality creative self-development [2] and identified a stage of self-development within the framework of personality development called the law of ensured education quality. Now good education is an essential condition of professional and career development which a modern personality is focused on. According to V.I. Andreev, creative self-development is a complex type of creative activities focused on subject-subject relation aimed to intensify and enhance "self-qualities", with self-updating, self-knowledge, and self-government being key ones.

Post-industrial countries, co-signatories of the Washington Accord (WA), including Association of Engineering Education of Russia (AEER) that entered WA in 2012, implemented the system of education

quality assessment based on the approved international criteria. Thus, high quality of engineering degree programs is ensured, which promotes graduate's certification, professional mobility, and successful employment in the countries of WA. According to the WA standards, one of the program quality criteria requires training to perform complex engineering activities [3].

Work [4] shows that professional competence of engineering graduates involves 12 professional competencies. The experts of AEER stated that leadership skills are the key criterion to assess the quality of engineering training in the Russian Federation.

The structure of leadership skills can be described in terms of psychology [5] and are defined as the individual ability for self-control and interpersonal relationship management. Leadership skills are conditioned by the level of understanding and management of personal and others' emotions, i.e. development of emotional intelligence – EQ.

The styles of leadership and the predominant characteristics of emotional intelligence are presented in tab. 1.

The leadership competency comprises four main components, each representing a set of skills and relevant professional qualities attributed to the leader in comprehensive engineering activity. They are consciousness, self-regulation, social empathy, and social skills. At Kazan National Research Technological University (KNRTU), engineering students were tested for leadership competency development via the technique elaborated at the Institute of Psychology of the Russian Academy of Sciences [6]. The results of research are provided in fig. 1. LL – low level; AL – average level; MHL – moderately high level; HL – high level [7].

According to the data obtained, more than 60% of engineering students have low and average levels of leadership competency development, which fails to conform to WA requirements. The contradiction between the level of

leadership competency development, professional requirements and suggested EQ structure indicates that there is cause-and-effect relationship between the improved leadership competency and the pedagogical system designed and implemented in professional education.

EQ is an effective management of individual behavior and relationships (social sensitivity and emotion control); it is a professional competency relating to comprehensive engineering activities [3]. As for development of individual intellectual resources, it is based on psychological model of intelligence developed by M.A. Kholodnaya and introduced as the individual mental experience (IME). Mentality is a way of the worldview in which conscious and unconscious, individual thoughts and emotions are inseparable. Personal development is the record of individual experience, which is the main cell in consciousness structure (L.S. Vygodsky). The conflict between conscious and unconscious emotions is the cornerstone of many psychosomatic diseases [8]. In terms of ontogenesis, emotional development is expressed through differentiation of qualities and degree of emotion awareness, as well as the ability to control and express emotions. Therefore, an increase in the degree of emotion awareness in the structure of IME leads to intellectual development of students and is reflected in higher rates of EQ. $EQ = PEQ + IPEQ$ (personal EQ + interpersonal EQ), where $PEQ = SA + SM$ (SA – self-awareness, SM – self-management), and $IPEQ = IU + IM$ (IU – interpersonal understanding, IM – interpersonal management). PEQ and IPEQ contributions to EQ development via technique [6] are provided in fig. 2.

Experimental data show that the engineering students have an average starting level of EQ development. It indicates the medium-developed ability to differentiate emotions and insufficient degree of emotion awareness in IME. The contradiction between the level of

Table 1. Characteristics of leadership styles EQ

Characteristics/ situational management styles	Authoritarian	Authoritative	Companionate	Democratic	Model	Training
Leadership style	Demands immediate obedience	Mobilizes people to embody the plans in life	Forms emotional relations and creates harmony	Tries to obtain unanimity by means of active involvement of employees in management process	Establishes high standards of productivity	Helps employees to develop perspective abilities
Motto of style	"Do what I ordered you!"	"Follow me, everyone!"	"People first of all!"	"What do you think?"	"And now do as I do!"	"Try this option"
Predominant characteristics of emotional intelligence EQ	Determination, initiative, self-control (Self-regulation)	Self-confidence, ability to empathize, ability to implement innovations (Reflection + Empathy + Social skills)	Capability to empathize, ability to strengthen social relationships and to communicate effectively with people (Empathy + Social skills)	Ability to competently deal with other employees, to manage teamwork (Social skills)	Determination, initiative (Self-regulation)	Ability to encourage development of employee's skills, capability to empathize, consciousness (Reflection + Empathy + Social skills)
Optimal conditions for implementation	Crisis situations, need for reorganization, difficulty of interaction with confrontational employees	Implementation of new ideas or pathway	Improvement of relationships between the employee or need for their hard work under complicated circumstances	Dissemination of corporate policy, consensus achievement, and search for highly-qualified personnel's ideas	Effective performance of highly-qualified team	Assistance to employee in enhancing their productivity or developing professional skills
Impact on work climate	Destructive	Extremely favorable	Favorable	Favorable	Destructive	Favorable

leadership competency development, professional requirements and suggested EQ structure indicates that there is cause-and-effect relationship between the increased IME level, education quality, and the pedagogical system designed and implemented in professional.

The analysis of works on pedagogy in the field of intelligence development shows that the authors develop IME only in terms of cognitive mental experience [1]. Development of IME and especially intentional and metacognitive mental experience are possible on the basis of

Fig. 1. Engineering student's leadership competency: levels of development

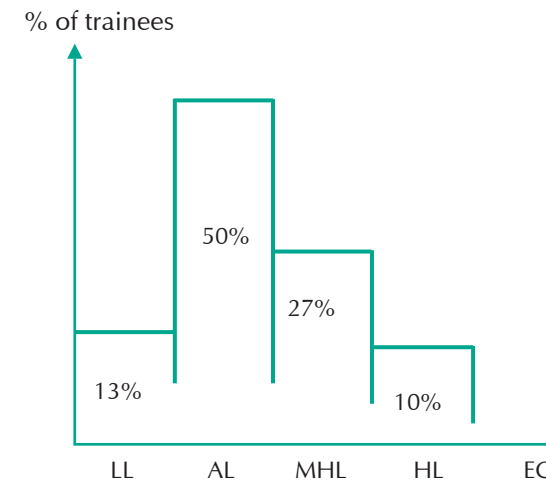
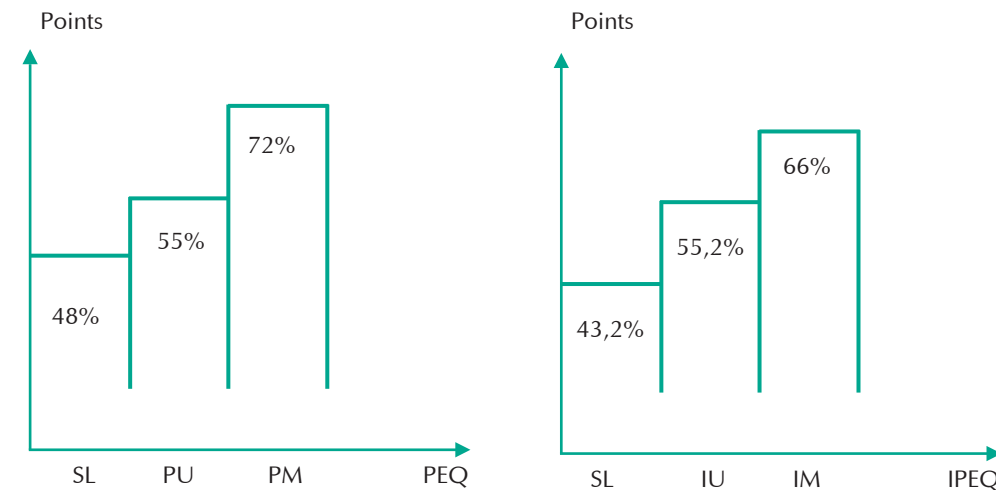


Fig. 2. The calculated levels of leadership competency development with regard to EQ structural element's contribution, where SEL – starting experimental level [6].



EQ structures. Intention is determined as a consciousness focus on any subject. Therefore, intentional mental experience is the focus of consciousness on effective self-management and management of relations with other people. Thus, IME with the emphasis on metacognitive and intentional mental experience is developed to increase the degree of emotions awareness, their differentiation and control over destructive emotions and impulses.

The hypothesis that individual intellectual skills can be improved via comprehensive engineering activity may be implemented through developing a pedagogical system on the basis of structural elements of emotional intelligence and adequate educational and methodical support. This support can be based on the theory of differential emotions (TDE) by K.E. Izard [8]. The results of TDE fundamental research allow

classifying basic emotions according to the criteria as follows: emotional expression, physical manifestations, reasons and functions, interaction with other emotions, emotional control and manifestations of psychosomatic frustration arising from of low capability to effectively manage destructive emotions. The structure of IME, which includes three types of mental experience (cognitive, metacognitive, and intentional), stipulates development of individual intellectual resources of a leader via comprehensive engineering activities.

The pedagogical model and educational and methodical support based on TDE are presented in tab. 2.

The rate of PEQ development of students doing engineering education programs at Kazan National Research Technological University was assessed via the technique developed by the Institute of Psychology of the Russian Academy of Sciences and with the educational and methodical support designed on the basis of TDE [5]. The results of research are provided in fig. 3.

Conclusion:

Development of students' individual

intellectual skills within implementation of psychological function ensures high quality of engineering education and is connected with the focus on self-management and effective communication (intentionality). More than 50% of students have moderate individual mental experience, which prevents them from reaching self-development level. The bases of pedagogical IME development model with the emphasis on development of intentional and metacognitive mental experience have been developed. The level of an increase in PEQ to moderately high level, 48.9 points, is experimentally determined; it corresponds to the calculated values provided in fig. 1. Development of PU emotions improves three first points listed in PDLs column on the basis of TDE pedagogical model (see the tab.). In the table, there are twenty PDLs involved in comprehensive engineering activities, as well as further ways to develop educational and methodical support for the pedagogical in terms of metacognitive mental experience (PM) to improve PEQ and develop IPEQ (IU + IM) up to the leader's rate.

Fig. 3. PEQ leadership skills development of engineering students at Kazan National Research Technological University: experimental levels (SL – starting experimental PEQ level of Kazan National Research Technological University) [6].

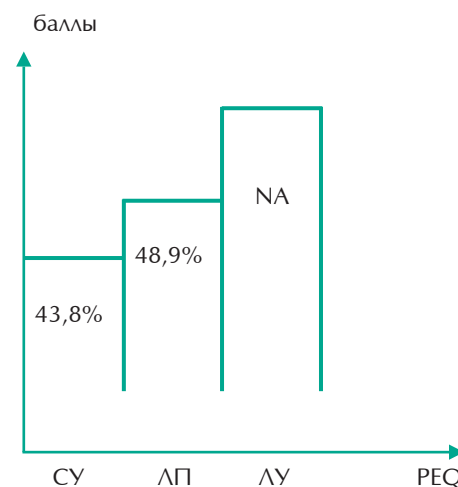


Table 2. Pedagogical model of IME development

Professional competence		
Intellectual competence		
Individual mental experience		
Cognitive mental experience	Metacognitive mental experience	Intentional mental experience (professionally demanded leadership skills, PDLs)
1. Ten differential emotions and awareness of their impact on individuals and their relationships: Interest-excitement; Pleasure-joy; Surprise-amazement; Anger-rage; Fear-alarm; Trouble-grief; Disgust-contempt; Confusion; Shame; Guilt. Awareness of disease symptoms: Schizophrenia; Depression when losing emotions; Maniacal aspiration to novelty; Sadism; Masochism; Bradycardia; Tachycardia; Gambling; Sleeplessness; Nonsense; Anorexia; Bulimia; Distress; Cancer; Rheumatoid arthritis; Psoriasis; Stomach ulcer; Epilepsy; Raynaud disease; Depression; Racism; Xenophobia; Alcoholism; Drug addiction; Suicide; Paranoia; etc. 2. Empathy.	1. Cognitive regulation; Emotional regulation; Motor regulation; Relaxation; Meditation; Formation of positive emotionality as a feature of the personality; Switching of attention; Disaccustoming from emotion; Sympathy awakening; Deprivation; Denial; Desensitization; Implosive therapy; Modeling; etc. 2. Situational leadership (management) styles [5]: Authoritarian Authoritative Companionate Democratic Model Training	1. Ability to analyze emotions and being aware of their impact on individuals and their relationships, etc. 2. Adequate self-assessment – understanding of strengths and weaknesses. 3. Self-confidence: self-esteem and adequate assessment of individual abilities. 4. Emotional control: ability to control destructive emotions and impulses. 5. Reliability: manifestation of honesty and frankness. 6. Work ethics: self-management and high level of responsibility. 7. Adaptability: adaptability to the changing situation and ability to overcome obstacles. 8. Achievement drive: persistent desire to conform to the inner quality standards. 9. Self-starter: readiness for active actions and ability not to miss an opportunity. 10. Ability to be sensitive, to understand alternative viewpoints and be helpful. 11. Business awareness: being aware of current events, organization hierarchy and policy conducted. 12. Courtesy: capability to identify and satisfy the needs of clients. 13. Strategic leadership: ability to lead and inspire people. 14. Power of persuasion: the ability to convince. 15. Encouragement of self-improvement: ability to encourage people to develop their abilities. 16. Communication: ability to listen and transmit clear, convincing and adapted information. 17. Promotion of changes: ability to initiate transformations, improve management methods and set new targets for employees. 18. Conflict management: ability to eliminate disagreements. 19. Strengthening of personal relationships: cultivation and support for social communications. 20. Team work and cooperation: interaction with other workers and teambuilding.

Particularities of Self-Study within “Electronics and Nano-Electronics” Education Programmes

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The paper considers the ways to organize student self-study within Electronics and Nano-Electronics education programs. The case-study is analyzed in terms of process approach to education and program interdisciplinarity.

Key words: student self-study, Master degree training, nano-electronics.

The successful progress of Russian enterprises in developing competitive products and solving import-substitution tasks is impossible without highly-qualified personnel and skilled workers who are adaptable, well-targeted, ready to self-improvement, self-training, and nonstandard solutions.

Today the most urgent problem is the lack of target-focused specialist training resulting in the necessity of “re-adjusting graduate training” for overheating of high-tech enterprises [1]. This primarily concerns the enterprises within the special technology development economic area (STDEA) “Zelenograd”. The task focused on training nanotechnology specialists is complicated by such facts as the interdisciplinary principles of problem-solving, relatively fast changes and ultra-fast emerging information from different sources, which, in its turn, stipulates the development of advanced personnel training programs oriented on the specific targets of this or that enterprise.

The characteristic feature of the Master degree program “Electronics and Solid-state Electronics” within the framework of education program 11.04.04 “Electronics and Nano-electronics” [2] is oriented on solving technological problems in the domain of both microelectronics and nano-electronics. In this case, the important factors involve technological

equipment proficiency, participation in R&D (micro- and nano-electronic device project development). The location of the University of Electronic Technology MIET in the special economic area and possible university profile development according with the Federal law 217, dated 02.09.09 set specific goals in training specialists, i.e. establishing new requirements for Master degree programs. The complex of education programs “Electronics and Solid-state Electronics” includes in-depth study of not only sophisticated technology for materials and electronic devices production, but also the development and establishment of the technology infrastructure, production metrology support and investigation of micro- nano-electronic units, as well as quality assurance. Practice-oriented programs, implementation of updated learning technology, development of “mobile” disciplines, being sensitive to the current research results, offer highly-qualified training for the graduates who will be involved either in leading positions or within the education and science domain and/or innovation activities. This could be promoted by well-developed infrastructure designing innovation SEA products, including business-incubator “Zelenograd Nano-technology Center”, which supports those entrepreneurs who strive to commercialize their project results within the domain of nanotechnology and

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