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**PERSON DEVELOPMENT TECHNOLOGIES TO ENHANCE SOFT
SKILLS OF ENGINEERING STUDENTS**

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Abstract

The importance of universal (non-technical) competencies or soft skills of engineering students is increasing in the modern world. To foster them engineering education needs to solve person development tasks. The current research is dedicated to the analysis of person development technologies focused on the improvement of engineering students' soft skills. The gained results allowed pointing out two groups of approaches having different person development potential. Problem-based and project-based learning, deep education and self-regulated learning do more to develop metacognitive abilities and interpersonal competencies. Reflexive learning, student-centered and person-oriented education, inspiring teaching and life-creating education do more to develop general attitudes and character traits or intrapersonal competencies. The research investigates the ways of the development of students' non-technical skills in technical environment: (1) special social psychological training sessions, psychological courses or programmes that train certain skills of engineering students; (2) organization of students' teamwork and self-regulated learning within the scope of project-based activity or studying technical disciplines; (3) activation of personal mechanisms of students' professional development by means of creating multivariate educational environment, reflexion in education, and support in self-realization. Features of education enhancing soft skills development of engineering students are pointed out and validated. The necessity of qualified humanitarian and social training of engineering students is highlighted.

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Keywords: Educational technologies, Engineering education, humanitarian training, non-technical (soft) skills.



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1. Introduction

The world is changing rapidly. To promote stable development of the community education should consider the trends of world development and should be oriented towards future.

1.1. New world – new education

Experts of the OECD Centre for Educational Research and Innovation have deeply studied the trends shaping education. The main characteristics of modern society and the problems to be solved by education in new reality are shown in their general report (OECD, 2016). Such global factors influencing education as environmental problems, mobility of population, the formation of knowledge-based global economy, escalating problems in ensuring health and safety of people, Internet and technology development, strengthening of virtual reality are pointed out. The experts highlighted the problems that education faces nowadays: promotion of students' creativity to bring up individuals capable of innovations; the need for knowledge and skills to be competitive in the era of globalization; relevant development of human powers to identify the required data in the information field, etc. (OECD, 2016).

The need to reform the models of education is due to a combination of challenges (Luksha & Peskov, 2015):

- Development of digital technologies and telecommunication systems changes the methods by which the knowledge is stored, passed and created; and skills are formed.
- The main part of new decisions for education is realized through technological start-ups. A new transnational market emerges out of the system of education. This market can replace traditional educational systems and form new standards quite rapidly.
- Economic dynamics in industrialized countries shape the demand for new types of competencies and skills and new forms of training.
- Education is now more often seen as an intangible investment asset.
- The educational system obtains a new type of 'human resource' to deal with due to the changing values of our consumer society. On the one hand, there is a growing number of learners who do not have a high valuation for education and less motivation to learn; on the other hand, there is a growing number of students who understand the importance of personal development, who are eager to set their own goals.

The main responses to these challenges are enhancing education and current competence building of students including future engineers as manufacturers of technological changes in the world.

1.2. Engineering education is oriented towards new functions of an engineer

Engineering education plays a major role in the world development (Prihod'ko & Solovyev, 2015). In engineering education there is a gap between engineering training and demands of modern industry, not sufficient practical orientation and applied character of higher education (Rudskoi, 2015). Modernization of engineering training starts from reconsideration of its objectives - requirements which a graduated engineer has to meet.

As a result of changing requirements of industry engineers need both non-technical and technical knowledge and skills to be successful in the contemporary world (Knobbs & Grayson, 2012). Young engineers need to have personal, interpersonal, and system building knowledge and skills to produce real products and systems, meeting enterprise and societal needs (Crawley, Malmqvist, Lucas, & Brodeur, 2011). Globalization intensifies the demands for social and global engineering communities. That is why such characteristics as cooperation, communication, collaboration, intercultural cooperation, sustainability, social and global responsibility become increasingly important for future engineers (Lappalainen, 2011). “Higher engineering education should offer adaptive education that harnesses the students with the ability for critical engagement and thought, interdisciplinary and original thinking, collaborative teamwork, and socialization into the engineering community of practice” (Lappalainen, 2011, p. 513). Therefore, universities need to play a greater role in strengthening students' nontechnical skills (Itani & Srour, 2016).

1.3. Universal skills of future engineers

A number of researchers highlight the importance of developing the following universal (nontechnical) competencies or soft skills of engineering students:

- an ability to measure up one's own resources and potential, reconsider one's own principles, justify and make non-trivial decisions which are important in innovation industry (Remorenko, 2011);
- an ability to work in a team and run project teams (Emilsson & Lilje, 2008);
- holistic social competencies of engineers which include: intrapersonal characteristics (self-regard, assertiveness, emotional self-awareness, independence and self-actualization); interpersonal characteristics (empathy, interpersonal relationship, social responsibility); stress management (stress tolerance and impulse control); adaptability (reality-testing, flexibility, problem-solving); general mood (optimism and happiness) (Lappalainen, 2011).

Modern engineering education in many countries is oriented to CDIO approach (Conceiving, Designing, Implementing, and Operating). It has CDIO Syllabus that is a rational, complete, consistent, and generalizable set of goals for undergraduate engineering education. Amongst the variety of engineering knowledge and skills there are interpersonal and intrapersonal skills such as personal values and attitudes (professional ethics, professional behaviour, integrity and social responsibility, currency in engineering, visioning for career and life, equity and diversity, trust and loyalty, perseverance, initiative, creative and critical thinking, and the skills of self-awareness and metacognition, curiosity and lifelong learning and educating, and time management) (Crawley et al., 2011).

Thereby, the problem of searching for ways and means as well as for effective educational technologies of engineers' training in higher education including the development of students' soft skills is relevant in modern science and educational practice

2. Problem Statement

In order to train highly qualified specialists by engineering education it is necessary to pay attention to a personal aspect of training. It is precisely personal characteristics that are the basis of soft skills of a professional (Lyz & Lyz, 2014; Exakusto, Duganova, & Zaichenko, 2013). That is why engineering education should meet personal development challenges. To develop personality of students it is important to use psychological-educational programmes and technologies (Klochko & Galazhinsky, 2009, p. 223). Such programmes and technologies enhance the following processes:

- determination of students' "personal presence" in education, their participation and influence on their education;
- creation of conditions for an educational choice, for determination of a person's way;
- ensuring students' formation of their own educational orientations, educational initiatives and their implementation in education, professional and research spheres;
- providing training for an innovative activity, for an activity under conditions of uncertainty and tough competitiveness;
- students' involvement into effective group interaction and joint activities (Almazova, Khalyapina, & Popova, 2017).

New educational technologies are widely implemented in modern engineering education. They allow not just transferring technical knowledge and skills but developing universal competencies (soft skills). Amongst different approaches ensuring versatile training of an engineer we can point out conceptions of problem-based, project-based, self-regulated, reflexive, student-centered and person-oriented learning; inspiring teaching and life-creating education.

2.1. Problem-based and project-based learning

Problem-based learning (PBL) is a tool by which students learn solving facilitated problems. Students study real problems which do not have any single correct solutions, but are typically complicated, open-ended, and ill-structured. They are to decide what they need to learn about and what skills they have to gain to manage the situation effectively. Project-based learning is specially organized self-managed educational and vocational activity of students in a small group through a body of search, problem-based, creative methods aiming at the creation of a specific product. The concepts of problem-based learning and problem-oriented project learning are seen in the following main pedagogical ideas (Andersen & Heilesen, 2015):

- acknowledgment of learner's experience as basic;
- interrelation of theory and practice;
- breaking the boundaries between disciplines;
- an emphasis on students who take responsibility for their own learning;
- change in the role of a teacher: from an instructor to a facilitator;
- change in a focus from staff assessment to peer assessment;
- a focus on the processes of getting knowledge rather than the products of such processes;
- a focus on communication and interpersonal skills.

Problem-based and project-based learning support students' motivation and facilitate a possible transfer from the study context to the context of professional work (Andersen & Heilesen, 2015). Project-oriented environment or project-and-team education technology (practice-oriented training) enhance the development of metacognitive abilities and communicative skills of engineering students (Chassidim, Almog, & Mark, 2018; Kovalev, Loginov, & Zelenkov, 2016; Kricsfalusy, George, & Reed, 2018).

2.2. Self-regulated and reflexive learning

Self-regulated learning is a kind of learning when students are heavily involved in self-planning, self-organizing, self-instructing and self-assessing. Self-regulation is students' involvement in the process of practicing some important skills like setting goals, thinking over strategies, and monitoring the results of their engagement. Sometimes self-regulating learners bump into obstacles, to overcome them and to make further progress students have to adjust their goals, sometimes reject them, they have to manage motivation and invent tactics. Self-regulated students' awareness of their knowledge qualities and their motivation helps them to judge how well they meet the standards they set for successful learning (Butler & Winne, 1995).

The organization of self-regulated learning is based on a phase model of self-regulation that is: (a) forethought, (b) performance and volitional control, and (c) self-reflective processes. During self-regulated learning students feel to be more effective, more autonomous and inner-motivated. They have higher learning outcomes, skills in self-managed activity, self-belief and other personal skills (Zimmerman & Tsikalas, 2005).

Nowadays reflexive learning becomes progressively important in the design of educational curricula. It shows the need to train students capable of learning and reflecting about their actions and the implications of their acts, so that they could be a part of a dynamic social, economic and technological environment (Cambra-Fierro & Cambra-Berdún, 2007). Self-regulated and reflexive learning enhance formation of planning skills, skills in self-assessment, in activity correction, as well as self-consistency and inner motivation of engineering students (Butler & Winne, 1995; Cambra-Fierro & Cambra-Berdún, 2007; Hiemstra & Van Yperen, 2015; Zimmerman & Tsikalas, 2005; Gashkova, Berezovskaya, & Shipunova, 2017).

2.3. Deep education

Deep education is a process of self-identification and meaning acquisition where knowledge is gained by resolving day-to-day problems. Deep learners try to grasp the meaning with the aim of transforming the given material. The main characteristic of deep learners is that they strive for knowledge. They intentionally involve themselves in the process of meeting challenges, use previously gained knowledge as a solid basis for learning new material, accumulate positive experience of education which will further make them feel self-confident in their abilities to understand and be successful (Tochon, 2010). According to Tochon deep teachers are learner-centered and their activity is based on the meaningfulness for learners. They organize learning discussions focusing on life goals and problems; comply with pedagogical ethics; offer unobtrusive collaboration working with various cultural groups (Tochon, 2010). Deep education is implemented in a person-centered educational environment: if

teachers are involved and oriented towards students, if they succeed in changing students' conceptions, then students are inclined to use deep approach. Those students who use deep approach can be characterized as open to experience, intrinsically motivated, self-confident, and self-efficacious (Baeten, Kyndt, Struyven, & Dochy, 2010).

2.4. Inspiring teaching

Inspiring teaching provides qualitative learning experience, successful management in class and student's behaviour, positive relationship and supportive climate, enjoyment and high level of motivation (Sammons, Lindorff, Ortega, & Kington, 2016).

Inspiring teachers show:

- love for profession, enthusiasm, and creativity;
- perception of students as unique persons, respecting them and cultivating positive relationship;
- provision of interconnection between learning and students' life experience (that makes learning purposeful, actual, and significant);
- manifestation of flexibility and adaptation of teaching activity pending the changes in plans during the lesson depending on the requirements and interests of the class (that promotes student engagement);
- a safe and stimulating classroom climate promotion, encouragement in an open and confident atmosphere where students feel safe and sound;
- clear and positive classroom management, clear instructions, support of academic and behavioural expectations and school-wide coherence, the right balance between firmness and friendliness;
- reflexivity and collaboration with other teachers;
- readiness to use innovations and new contemporary approaches in education.

2.5. Student-centered and person-centered education

Classical models of person-centered education and learner-centered education are the results of different traditions but are quite similar in their teacher-student relational characteristics (Cornelius-White, 2007). They suppose:

- respect and acceptance of student's personality, understanding, empathy, authenticity and open interaction;
- creation of safe and confident educational environment;
- non-directivity of interaction (in most cases activity is initiated and regulated by a student);
- adaptation to individual needs and cultural diversity, flexibility in choosing teaching methods, the usage of contracts for planning and evaluation;
- solution of relevant and real problems, encouraging learning and critical thinking (as opposed to traditional memory emphasis).

It is stated that person-oriented education positively influences students' person development and provides high cognitive, affective and behavioural outcomes (Cornelius-White, 2007).

2.6. Life-creating education

The development of person-oriented approach is due to the conception of life-creating education. The main characteristics of such education are:

- an interest and involvement of students into cognitive activity;
- co-creativity and personal knowledge production;
- self-searching, self-determination and learners' personal fulfillment.

The process of learning is integrated with self-fulfillment, and students gain experience of self-management and management of different kinds of activities besides subject knowledge. So not only the result is valuable, but the educational process, simulating the modern world and providing students with different situations to try themselves in various roles (Lyz & Opryshko, 2016).

Thereby orientation towards person development of students is necessary in training of a modern engineer including soft skills training. Such situation inquires the use of appropriate educational technologies and the design of special characteristics of education. However, possibilities of the above-mentioned modern educational technologies in soft skills development of engineering students are not systemized. Appropriate conditions of education are not enough studied in engineering pedagogy.

3. Research Questions

- Which approaches and educational technologies are more suitable for personal development of students?
- What are the ways of developing non-technical skills in technical environments?
- Which characteristics of education enhance soft skills development of engineering students?

4. Purpose of the Study

The purpose of the study is to analyze the peculiarities of modern approaches to education and educational technologies and to elicit their opportunities for personal development of students; to study the ways of the development of students' non-technical skills in technical environment; to define certain characteristics of education which facilitate the development of soft skills of engineering students.

5. Research Methods

In the process of study we analyzed world teaching experience in engineering education; compared the possibilities of different approaches and educational technologies; systemized; theoretically modulated; surveyed students' subjective points of view on perceived value of the course.

6. Findings

6.1. Contribution of educational technologies in personal development of students

On the basis of theoretical analysis among different approaches there were pointed out two groups of approaches which have different possibilities in personal development of students.

The first group consists of educational technologies and approaches which in a major degree facilitate the development of metacognitive skills, interpersonal skills and team work skills: communicative skills, empathy, interpersonal relationship, social responsibility, flexibility, cooperation, readiness to work along with others, conflict handling, an ability to manage one's own activity. This group includes problem-based, project-based, self-regulated, and reflexive learning, and deep education.

The second group of educational technologies in a major degree facilitates the development of general attitudes and character traits or intrapersonal skills: self-awareness, independence responsibility, self-regard, confidence, and self-actualization. This group includes inspiring teaching, reflexive learning, student-centered, person-centered, and life-creating education.

All the approaches and educational technologies highlighted above enhance to a different extent purposeful development of students' personal qualities that is to say they are person-developing. Since the personality is integral the development of some of its qualities (i.e. intrapersonal competencies) leads to the development of other qualities (interpersonal competencies). Moreover, each approach can have different opportunities depending on the conditions of its realization. So, this classification is nominal. It shows main contribution of modern educational approaches and technologies in person development of students.

Considering modern educational technologies as a tool of developing students' soft skills we did not regard the use of information technologies. It is necessary to point out that it is not so much e-learning or online learning but blended learning that is person developing because it widens the opportunities of educational environment and opportunities to self-regulate learning.

6.2. Non-technical skills development in technical environment

On the basis of the given analysis we can point out three approaches to students' soft skills development in technical environment. The first approach entails special psychological courses, social psychological training sessions or programmes that train certain skills of engineering students, i.e. communicative skills (Emilsson & Lilje, 2008) or leadership (Goertzen & Whitaker, 2015). This approach is the most focused, intensive, and efficient.

The second approach is organization of students' teamwork and self-regulated learning within the scope of project-based activity or studying technical disciplines. For example, teamwork in engineering projects in the competition formats and introduction of the compulsory module "Project activity" in the educational process (Kovalev et al., 2016). Using this approach, it is necessary to observe the balance between pedagogical management and self-organization of students, to moderate group processes as well as to maintain students' reflexion of their own activity and self-esteem of its results.

The third approach is activation of personal mechanisms of students' professional development by means of creating multivariate educational environment, providing students with conditions to choose their own educational vector, reflexion in education, and support in self-realization. In this case, students' individuality, interests and goals are taken into account as well as the processes of their self-awareness and self-determination are supported in order to widen new opportunities in personal and professional self-development (Lyz & Lyz, 2014). This approach is implemented not only as a part of educational programme but beyond the scope of it. It has rather significant potential which is not obvious at the first

sight. Nowadays this approach is more efficient in humanitarian and social training of engineering students.

6.3. Features of education facilitating soft skills development of engineering students

Analyzed and synthesized features of above mentioned approaches and educational technologies allowed us to point out the following conditions of soft skills development of engineering students:

- support of students' activity and motivation;
- learner's interactions with peers (cooperation, peer learning and social context);
- positive teacher-student relationships, non-directivity, empathy, thinking and learning support;
- reliance upon students' level of development, their previous knowledge and capabilities; their readiness to think, their interest and involvement into educational activity;
- transfer from the study context to the life and professional work context, solving real problems;
- students' reflection of their own knowledge and effectiveness of the used management, communication and interaction strategies;
- attention to values, norms, attitudes, and skills which are activated in learning situations;
- activization of students' critical attitude, ability to learn from their mistakes, to present and evaluate alternatives;
- students' self-determination and personal fulfillment support.

These features of education for the development of students' soft skills were implemented in the educational course "Psychology of personal resources management". Students' subjective opinion survey (on perceived value of the course) revealed students' satisfaction with education, and soft skills development was evaluated positively. The aspects which were evaluated by students as developing in the process of such education are:

- understanding of one's own goals, capabilities and limitations;
- experience in educational activity management;
- broadening of educational and professional interests;
- interpersonal communication skills;
- confidence in communication in small groups.

Thereby, empirical teaching work validated possibility of soft skills development of engineering students in provision of training in accordance with the highlighted features.

7. Conclusion

The Eighth World Engineering Education Forum 2014 in Dubai stressed the general direction of changes in teaching methodology – implementation of student-centered, project-based learning and its realization: PBL – Problem-based learning, CDIO – Conceiving, Designing, Implementing, and Operating (Prihod'ko & Solovyev, 2015). Actually, these approaches facilitate complex training of future engineers including the development of students' soft skills. However, as the analysis found, it is necessary to use other possibilities of person development of engineering students along with the given ones. Not only problem-based and project-based learning has person developing potential but self-

regulated, reflexive learning, deep, student-centered and person-oriented education, inspiring teaching and life-creating education as well. Besides that, it is important to point out the necessity of qualified humanitarian and social training of engineering students which activates personal mechanisms of professional development.

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