Development of entrepreneurship skills for students creative thinking support in higher education

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***Abstract* —the development of entrepreneurship skills for next generation of students is a priority for Latvian Ministry of Science and Education (LMSE). In order to promote the development of students' innovation and entrepreneurial abilities, the LMSE has developed a new model of student grant system, which was supported by the Cabinet of Ministers. The new efficient methodology approach for entrepreneurship skills development from a school by the higher education level and promotion of business development skills on the next education stages is the aim of this paper. The paper describes an approach that combines Project Based Learning method applied for the acquisition of product prototype design and planning skills by the students of electrical engineering branch. The work is based on the principle that the complexity of entrepreneurship, entrepreneurial competences and the ability to find a universal set of personal characteristics and environmental factors that would classified one individual as entrepreneur.**

Keywords—education entrepreneurship, creative thinking; product development; higher education.

I. INTRODUCTION

The entrepreneurship skills development in the different areas of technology applications are the challenge for education of next generation of students. The development sustainable methodology on education approach of new students' generation in entrepreneurships is a challenge for the higher education establishments in Latvia. There is already developed and approved strategy for schools, which are related with entrepreneurship skills developments in the pre-university stage. There has been increasing research interest in the influence of entrepreneurship and education on the entrepreneurial behaviour of students, especially in Eastern European countries during and after the transition period [1]. The introduction of new education standard mean changes of usual education approach in schools, this standard will be introduced in Latvia from September 2020. [2].

Implementation of the standard for schools will open a link from the school, to the higher education, and real live. The education of new generation opens new challenges for links from school to undergraduate students' level. Latvian National Centre for Education Content explains that schools will either be able to use pre-formulated curricula or build their own, including school curricula and teacher-developed lesson plans. In the new curriculum, the teacher is the leader of the learning process, who not only provides knowledge, but takes the students to the answers rather than giving them ready. The content is complemented by a set of skills and habits based on values, so that the learner learns to learn throughout his life and to act in accordance with his values on a daily basis. Skills such as critical thinking and problem solving, creativity and entrepreneurship, collaboration, civic participation, digital skills are permeating all learning content. The content offer also includes a technology area with a number of content blocks, including engineering and computer science, to be taught in the field or as separate subjects according to the age of the pupil and the educational program implemented by the educational institution. The subject "Design and Technology" is offered in all primary school classes, with the central aim of acquiring the design process and experience with different technologies. In the 7th grade pupils will have the opportunity to master a new subject "Engineering" [3]. In order to attract more students to the private businesses the

development of students 'innovation and entrepreneurial abilities, the Ministry of Science and Education and (MSE) has offered a new model of student grant system [4]. The main objective of grant system is to support students' innovation projects and research, while strengthening cooperation between the higher education institutions and the industrial companies, aiming to enlarge contribution of the non-academic sector, opening for students of gaining of necessary personal expertise and industry - relevant skills development during the industrial secondements and development of the industry – oriented projects. The establishment of such grant system in year 2018 was supported by the Cabinet of Ministers, approving the draft Cabinet of Ministers Regulations drafted by the MSE.

II. PROMOTING OF ENTERPRENERSHIP

The attracting of the students to entrepreneurship activities and promoting of the successful experience of business cases are developing of mutual understanding among business and next generation of technical specialists in the fields on the way. The understanding, self-involving and continues support of students in the developing of innovations, as well as promoting the new product lunching experience is a solid background for well-balanced career development in any type of business structures.

The experience of Latvia and Croatia in the free market economy developing experience is important, in order to benefit from European Union economics principles. For example, the University of Split has a short history of formal education, with the major in entrepreneurship, which started five years ago, when the Bologna process was implemented. The first students who graduated the entrepreneurship course, finished their study in 2010. Riga Technical University is promoting of innovation management module for all engineering specialties in the undergraduate stage of studies.

Entrepreneurship has been a part of the curricula in higher education institutions in North America for more than 50 years [1]. The first graduate course in entrepreneurship was offered at Harvard University in 1948 by Professor Miles Mace [5]. Soon after, Harvard Business School Professor Georges Doriot originated the concept of venture capital. Today, entrepreneurship courses are offered at most universities across the United States and worldwide. The demand has been driven by the students themselves, who are eager to take courses, ranging from business planning and start-up, to entrepreneurial finance and technology management. Universities in many countries have followed the example of US institutions and have instituted a wide range of entrepreneurship education efforts [6, 7].

Latvia experience of education system changing up to now is based on innovation oriented and business creation skills developing. The problem of students' motivation and keeping them engaged on the way, after they already were trained in the school, is an actual challenge for Universities of Latvia. In addition to the standard education, there are several active industrial societies, which are developing the industrial clusters, and attract students to continue education in the entrepreneurship in addition to the main fore, for example engineering.

III. THE EDUCATION SYSTEM

The education system in Latvia 9-year that includes a basic education (primary and lower secondary education according to ISCED) is compulsory for all children from the age of 7 and is generally completed till the age of 16, but may continue till the age of 18. There are two types of programmes at the secondary education level: academic secondary education programmes and vocational secondary education and training programmes. Continuing vocational training or in-service training programmes can be acquired after graduating general or vocational secondary education and training institutions (duration 1 to 3 years) or in up-skilling/professional development programmes (duration not less than 160 study hours, which may be considered as a partial qualification). Two groups of programmes can be distinguished: academic programmes and professional programmes. Academic higher education programmes are based upon fundamental and/or applied science; they usually comprise a thesis at the end of each stage and lead to a bachelor's degree or master's degree (see Fig.1). A master's degree or the equivalent degree (graduates of 5-6-year professional higher education programmes in Law and Medicine can continue education at postgraduate level directly) is required for admission to doctoral studies (Ph.D.). Doctoral studies last 3-4 years full-time [8].

The education of PhD is based on the research based approach. Research and students training at RTU is organized around six technology and research platforms: Energy and Environment, Cities and Development Information and Communication, Transport Materials, Processes, and Technologies and Security and Defence. The objective of the platforms is to ensure multi-faculty and interdisciplinary research in the areas of great significance for the national economy and society. Active and continuous analysis of market needs and commercial potential takes place within the research platforms.

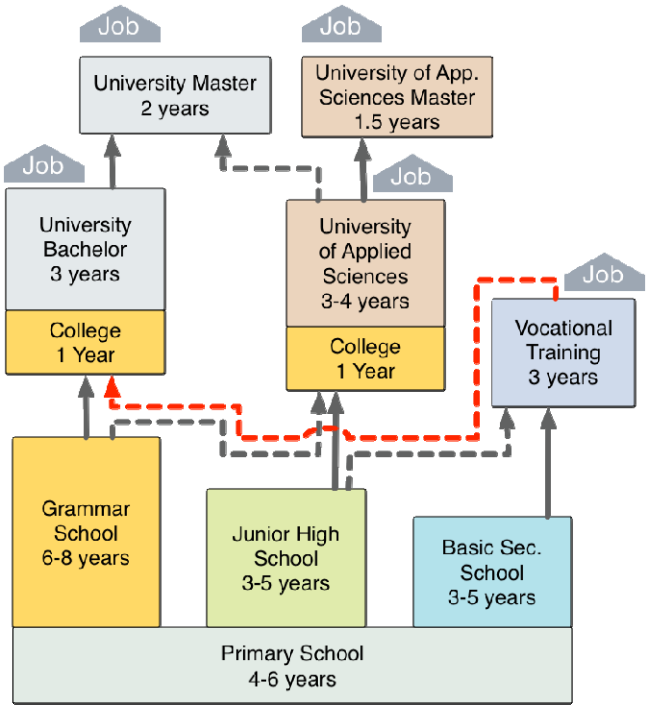

Fig. 1. Education paths with college phase

RTU has established a comprehensive network of branches outside the capital city Riga in order to promote intellectual development in the regions of Latvia and to educate and train qualified workforce close to their place of residence in different parts of the country. RTU affiliations have been established in four Latvian cities – Cesis, Daugavpils, Liepaja, and Ventspils. RTU affiliation development policy envisions implementing study programs adapted to the needs of the economy of each territory, as well as improving availability of higher education in the regions of Latvia. The Liepaja and Daugavpils affiliations are situated more than 200 km from Latvia capital city Riga, those regions are situated in the bad economic situation, so the approach of students' engagement should be specific.

IV. ENTERPRENERSHIP

Over the last few years, in a line with technological development, the trend of opening small and medium-sized enterprises is increasingly emphasized. The countries have become more aware of the impact of these types of business on economic growth, so the European Commission in 2013 stressed the importance of entrepreneurship and states "to bring Europe back to economic growth and higher levels of employment, Europe needs more entrepreneurs".

However, to encourage entrepreneurship development [9], the main question arises: "What does this motivate the individual in his entrepreneurial intent?" [10]. The Faculty of Economics and Business of the University of Split, focuses on the exploring entrepreneurial intentions among the students. The study convincing has proved the complexity of entrepreneurship and entrepreneurial intentions and the inability to find a universal set of personal characteristics and environmental factors that would classified one individual as entrepreneur.

A sample of 143 subjects was tested according to Big Five Model [11] of personality traits, demographic characteristics, environmental factors, and by estimating their own abilities and opportunities toward entrepreneurship. Numerous studies, including the aforementioned, indicate that entrepreneurial intentions are influenced by numerous environmental and personal factors, whose intensity varies depending on how an individual evaluates the importance of each element. The solution for this problem should be in systematic changes and development of new concepts, such as hybrid entrepreneurship, to facilitate entrepreneurial ventures and develop a positive entrepreneurial culture among students.

Entrepreneurship intentions were observed trough five main personal characteristics, with a presumption that those respondents, who possess higher level of openness to experience, conscientiousness and extraversion are more likely to become entrepreneurs in future. Opposite, others who have more presented two last characteristics, such as agreeableness and natural reactions, are less likely to become entrepreneurs in future.

The results of individual assessments according to the Big Five Model are available on Fig .2.

Fig. 2. Results of testing entrepreneurial intentions among the students according to Big Five Model

The technological development, industry interests and availability of new developers, as well as support of experienced academic staff open new opportunities for the testing of new ideas and development of construction and prototyping skills in groups of undergraduate students is the basic motivation for strengthening of creative thinking.

There are five fields of specialization at the graduate program: Financial Management, Management, Marketing, IT Management, and Accounting & Auditing. Upon graduation from any of the two-year graduate programs, a student is awarded the academic title of Master of Economics (MSc). The curricula of the above-mentioned courses are designed to enhance entrepreneurial skills and students' entrepreneurial orientation.

The created a composite variable [12], which can reflect the students' level of entrepreneurial orientation, is called Students' Entrepreneurial Orientation in Business (SEOB). The SEOB variable is composed of six items, reflecting students' attitudes towards future plans for employment, or starting a business (i.e. becoming an entrepreneur). These items are: plans after study (employment or entrepreneurship), participating at Industry Days (i.e. job fairs), work preferences (public sector or private sector, thinking about one's own business idea, if unable to find a job, business idea generation, already working on a business idea during the studies.

The survey results provide an interesting picture of the students from the Faculty of Economics, University of Split, as they reflect the lack of their entrepreneurial orientation. The mean values of the SEOB composite value of 1.83 and 2.27, on a scale from 0 to 6, prove such a statement.

V. METHODOLOGY

The Riga technical university uses Project based learning methodology - PBL method, which is one of the most important methodological issues for acquisition of prototype design and product planning skills by the students of electrical engineering branch. The PBL approach in RTU is extremely important, for developing market oriented products and technical progress. PBL in general provides complex tasks derived from challenging questions or problems that involve the students in problems solving, decisions making, and investigative activities. The PBL is incorporated in RTU research and academic structure and encourages students to continue a career in the academia or research. The work with PhD and master students is successfully transferred to the publications, like research on

and High Efficiency Modular DC-DC Power Converter for Adaption to Industrial & Hybrid Robotics [12] and High-Frequency Modelling of EMI Filters Considering Parasitic Mutual Couplings [13], as well as leads to multidisciplinary research with several universities, like Early diagnostics of real time technical condition of steel shafts [14], and results of H2020 projects, like AREUS - Innovative hardware and software for sustainable industrial robotics. PBL is focused on the questions that drive students to encounter the central concepts and principles of a subject hands-on. PBL approach supports students learning and practicing skills in problem solving, communication, self-management, it encourages the development of habits of mind associated with lifelong learning, civic responsibility, and personal or career success. Application of PBL in RTU encouraged creation positive communication and collaborative relationships among diverse groups of students, because it meets the needs of learners with varying skill levels and learning styles.

The most advanced students could be authorized to independently manage a project team. Therefore, student step by step moves forward starting from the projects to commercialization of own developments. The task of a course and a program developer [16] is to plan the classes, so that the applied activities could involve students into more active roles even up to they could take their initiative and design and create ideas themselves, making the studies more learner-oriented. Therefore, we come to the idea of so called learner-outcomes-oriented course design. The specific interest in this area is caused in the field of engineering higher education. In 1959, an American researcher Donald Kirkpatrick model proposed four-evaluate the effectiveness of learning, which is widely used today in classic approaches [17].

The levels of effectiveness of learning offered by D. Kirkpatrick:

- The first level - "The reaction of participants" aims to identify, the participants enjoyed the training. To assess this level use standard profiles.
- The second level - "Education" determines how the knowledge of the participants changed as a result of training and whether they have changed at all. To assess this level of use specially designed tests and assignments that allow to quantity progress in the competence and motivation of participants
- The third level - "Application" identifies whether to apply participants received during the training knowledge and skills in the workplace? Is there a real difference in their work? Evaluation at this level is usually performed by tools developed on the principle of "360 degrees".
- The fourth level - the "Results" has the objectives to determine the changes in the economic activities of the company, as a result of learning. This level is usually the most difficult to measure, particularly given the fact that also affected business performance and other factors, and to isolate them practically impossible to effect.

However, the model of D. Kirkpatrick despite the simplicity and easy use suffers from a high degree of subjectivity and does not provide quantitative indicators of the effectiveness of learning. In 1991, another American investigator - J. Phillips - added the fifth level to the Kirkpatrick's model evaluation - ROI (return on investment in learning). His model is now recognized as "American Association of Training and Development" (ASTD) and is used around the world.

Thus, to evaluate the effectiveness of training, you can use different models, each of which has its own advantages and disadvantages. The choice of a model depends entirely on the objectives set by the professionals involved in the assessment. D. Kirkpatrick model allows to quickly get a clear picture of the effectiveness of training activities. Model "A Taxonomy Bloom" [16] allows to make a more detailed assessment of the efficiency, as well as the choice of specific learning strategies. Model of J. Phillips aimed to assess the financial side of learning.

The also approach of Social innovation [18] need not be a one-off project or initiative within a company. Supported by an entrepreneurial mind set, it can be a constantly evolving process that generates new sources of social value while supporting a company's business growth and market competitiveness.

Step 1: IDENTIFY Collaborate with those who understand local social needs: Telenor and UNICEF collaborate globally to jointly identify opportunities where innovative mobile solutions can help children in all markets where Telenor operates.

Step 2: DESIGN Co-design locally relevant products and services: Siemens Stiftung and the European Union provided financial support; and Light for Life and Thames Electricalled and supported the implementation on-site.

Step 3: LEARN Leverage experts to measure outcomes: Using a measurement model developed by the Commonwealth Scientific Industrial Research Organization (CSIRO) and an SMS-based technology platform offered by Vodafone, the company surveys local stakeholders to understand levels of trust. Real-time inputs generated through the surveys inform the company's future decisions and programs.

Step 4: SCALE Adapt partnerships as you scale: From 1997 to 2015, Cisco grew from 37 networking academies in the United States to 9,500 academies in over 170 countries. In addition to leveraging the power of the internet, Cisco relied heavily on partnerships to grow rapidly. The company works with governments, educational institutions and community-based organizations around the world that are responsible for finding classroom space and teachers, attracting students and purchasing laboratory supplies for the classroom. As it grew, the number of its partners across the world grew. Providing opportunities for academy partners and instructors to connect, collaborate and learn from each other has been critical to the program growth and sustainability, while partnerships with non-traditional institutions such as prisons have also provided new opportunities for IT skills development for underserved populations.

Partner with peers on shared interests: Many companies share the same interests or are exposed to similar business risks. Nestlé and M&S, for example, both identified addressing the looming cocoa shortage as a strategic priority. By becoming members of the industry coalition "World Cocoa Foundation," both companies can collaborate with others to foster a sustainable cocoa economy by improving production practices across the industry.

The application of mentioned methodology approaches, allows to develop new market products, from idea till mass market product in the university laboratories.

VI. DEVELOPING OF PROTOTYPES

The students on master level was developing group project (Fig.3.). This project presents the design and construction of a battery management system for Lithium-Ion Battery. A battery charger is an electrical/electronic device used to put energy into a secondary cell or rechargeable battery by forcing an electric current through it. But it is also essential that each of the battery get same amount of voltages & current. This report contains fundamental of equal voltage distribution assembly for three LI-Ion Battery. The system consists of a step down transformer, an AC to DC converter and a DC voltage regulator. The circuits are designed using copper wire, rectifier diodes, electrolytic capacitors, resistors with other passive and active component of electronics. In the result of project, the circuit, working as battery management system was created. Each of the terminal is equally discharging voltages, and circuit also can be used to balance the battery separately from the charger. Furthermore, this principle can be used to provide equal voltage and current for all nodes of wireless sensor network with some implantation and modification.

The testing of the new study courses and training methodology was arranged in small groups during short visits of international students. Apart of national standards, which are mandatory for all study programs, the mutual recognition of innovation implementation approach is important for international education approach, programs, since it supports international students career.

Training of the students is provided, using laboratories of the research based educational programme "Computer control of electrical technologies". Every day research activities are an integral part of the routine work of the staff of the Institute of Industrial electronics and electrical engineering (IEEI). This study and research program comprehends the broad area of industrial electronics and electrical engineering with the specializations in power electronics, adjustable electric drives, automation of electrical technologies and electric transport, and it meets the needs of the industry and makes the graduates being competitive at the world labour market.

The standardization of different topics allows creating the best practice, based training materials and lecturing notes. This approach is already partially used in Riga Technical University for foreign students training.

Fig.3. Students and teachers during the prototype design process

The practical training Smart pill box (Fig.4.) development project was a challenge for students, the initially thought of using a micro solenoid for the control of gates, but we had to deal with a huge setback considering the solenoid was a failed idea. We then decided to control the gates with a more convenient way by using a micro DC motor.

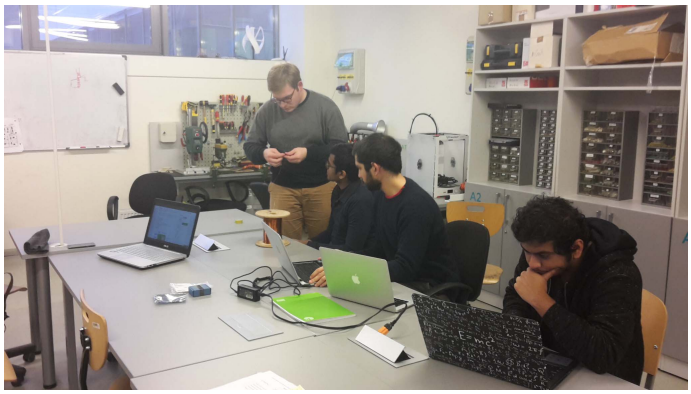

Fig.4. During'Smart pilss" prototype creation process

During the course of the development the students found out that it is hard to implement app based control of the smart pill box, however they managed to do it with Bluetooth connectivity. In this course, the involvement of students in the idea development process through individual contribution and group training was successfully tested. As a result, a prototype of the product on technology readiness level 3 was developed by the student groups. The results were presented in the pitch presentation.

The testing of offered students training approach was finished with presentation of practical prototypes (Fig. 5).

The students of non-engineering specialties integrated themselves in the engineering environment very well, and in two weeks where able to demonstrate prototype of market – oriented product.

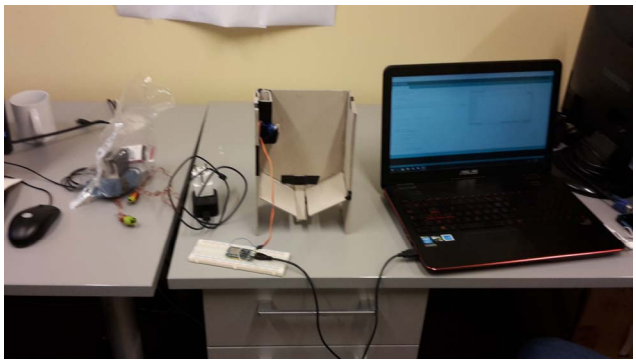

Fig.5. During the demonstration of product prototype

The development of mutually recognized approach for the development of new products, the testing of this approach for different groups of students, especially in international groups provide a good solid background, which is useful for RTU, as well as for industrial partners and will be elaborated in the common report of recommendations, in a frame of the students' project.

CONCLUSIONS

The development of entrepreneurship, as well as training of students on the creating of a prototype of the product for a real market is very important. The ongoing industry – academia cooperation encourages creative thinking skills of undergraduates' students in the process of creating the first concept, acquisition of necessary software and hardware components to build a prototype of a new product.

This approach comprises a module of professional business-competence creation: innovations management, business organization, management methods, business economics, project development and management, financial accounting, knowledge of the regulations concerning employment, social dialogue, as well as entrepreneurship of start-ups, crowd financing and co-working through the students' incubators and programs. This approach motivates to create new ideas for start-ups and is useful, because allows in practice to develop entrepreneurship skills during the education process of the Riga Technical University and the University of Split.

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