Anna KIEŁBUS

Innovation and creativity of students

Innowacyjność i kreatywność studentów

Key words: innovation, creativity, market analysis, production engineering.

Słowa kluczowe: innowacja, kreatywność, analiza rynku, inżynieria produkcji.

Streszczenie. Obecnie, w obliczu coraz silniejszej globalnej konkurencji, kapitał ludzki o odpowiednio wysokich kompetencjach i kwalifikacjach dostosowanych do wyzwań zmieniającej się rzeczywistości stanowi jeden z podstawowych warunków szybkiego rozwoju gospodarczego i rozwoju społeczeństwa. Większego znaczenia nabiera kreatywność pracowników. Pracodawcy wymagają od pracowników kreatywności, jednocześnie coraz więcej osób kładzie nacisk na: odkrywanie swojego potencjału, samorozwój czy twórcze działanie. W artykule przedstawiono wnioski z badania marketingowego przeprowadzonego w 2015 roku wśród studentów Zarządzania i Inżynierii Produkcji reprezentujących I i II stopień studiów stacjonarnych i niestacjonarnych, dotyczące postrzegania swojej kreatywności, również w odniesieniu do oferty kształcenia zaproponowanej przez uczelnie. Podjęto próbę oceny możliwości pobudzania kreatywności studentów oraz kształtowania postaw proinnowacyjnych w polskich uczelniach technicznych.

Introduction. Competency requirements of the labour market are not static. According to J. Żyry: „there is new importance on the ability to properly" read „signs coming from the labour market in order to distinguish constant trends from short-term trends typical to fashion". „For example, for technical studies it is essential to resolve whether the profile should be widely or narrowly specialized. The postwar period was dominated by specialised technical studies but with time, there was a need for more general studies. In recent times the need for specialised knowledge has returned but with extended preparation in the field of so-called „soft" competencies (communication, teamwork, stress resistance, time management, etc.).

Coping with pressures to adapt the process of higher education to the dynamic external situation (the labour market) forces: changes in the attitudes of both teachers, students and university administration, updating curricula and providing for measures aimed at improving the quality of education, as well as the effective management of competences" [1–3].

Increasingly, employers demand employees' creativity, often combined with innovation. At the same time more and more people emphasis on self-development, exploring their potential and creative activity. What really is creativity and innovation [4, 5] and where should their beginning be sought? How can one unlock inherent creative thinking? Well, creativity and innovation initiated by the teacher or lecturer, is

the first link of a complete education system, which enables the development of human capital. Another is an honest student holding the element of creativity in their personal characteristics and the employer waiting for the perfect engineer – creator. These three links are the backbone of the modern economy, based on a triple system, ie. research, development and innovation [6–9].

Therefore, to investigate the creativity and innovation of students from the students' perspective, to review the offers of higher education can be helpful both to improve their level of creativity and innovation in the labour market, as well as in the development of research aimed at developing methods and tools to support the transition from an innovative idea to an innovative product [10]. Unfortunately, at present the complete process: from the idea of a new product to its market success is rarely carried out by one person. There is a barrier between the sphere associated with creativity, where new ideas are born (often as inventions), and the sphere related to their commercialization. There is lack of determination in the manifestation of entrepreneurial attitudes among students. The reason may be the lack of well-known and good practices which is associated with ineffective methods of teaching in this area [11]: there is lack of practical knowledge supported by examples concerning the commercialization of ideas and inventions generated by students.

It is also possible to have a different approach on the issue of creativity and innovation of students. It can be assumed that the time of study is a period of intensive study to acquire and develop the skills and habits of creative thinking. While innovation, understood as the transformation of these ideas into marketable products, does not play a key role in this period. There is some reference to the opinion of Albert Einstein on the study: „Education is what remains, after we forget everything we learnt in school". Therefore, study is a time of training the mind and as well as the development of creativity. Subsequent careers use the skills of creative thinking and innovation to create [11].

Theoretical Framework. The term „creative" means a mental process that results in the creation of new ideas, associations, and concept [12–15]. Being inspired by the ideas of others does not mean that we cannot be considered as creative. After all, even avant-garde artists of their era imitated or contested the work of their predecessors. Nobody acts in vacuum. Everything is based on what others have invented, because it must be drawn on the achievements of previous generations. Please note that creative thinking is a mental process entailing the formation of new ideas, concepts or relationships with existing ideas and concepts [14, 16]. The person who inspires others' ideas cannot be considered to be less creative.

Moreover we should perform tasks that force the brain into thinking and derive lifelong learning of new things. Keep in mind that the brain needs comprehensive gymnastics, activating its different areas and associating with different types of intelligence. It should ensure a more comprehensive development than only focus on investing in one type of skill. It is best to choose activities that give pleasure. To support creative thinking different techniques as brainstorming, mind mapping (mind maps)can be used, or TRIZ method 6 hats Edward de Bono which consists of looking at the

problem from six different perspectives (eg through emotions, facts, optimistic and pessimistic approach) [17–20]. These techniques can be successfully used both in teamwork, as well as the independent finding solutions to problems.

Methodological – research methodology. At the turn of 2014 and 2015 the project team Department of Process Engineering Production at Cracow University of Technology conducted a marketing research on examining the attitudes of pro-innovation and creativity of students of Management and Production Engineering field of study conducted in Poland. A developed questionnaire was sent electronically to the guardians of the Management and Production Engineering (ZiIP) in 51 state and private universities, (according to data from Ministry of Science and Higher Education academic year 2014/2015), the role of which was to raise the interest of students in completing the questionnaire which was available on-line [10, 21].

The survey was conducted by full-time students of grade I, II and III of the Management and Production Engineering. The questionnaire consisted of 26 questions (18 closed and 8 open ended) connected to three thematic blocks. The first block, enabled an assessment of the educational offer by alma mater university in terms of formation of the attitudes of pro-innovation. The second concerned the self-esteem of the students in the field of creativity. While the third provided official information about the respondents.

At the invitation of Cracow University of Technology to participate in the survey 18 universities (including 15 state-owned) responded. Due to the very low responsiveness, a detailed analysis was undertaken for the six colleges (one private and five public) conducting education in the first stage of full-time studies.

The scope of the study includes an analysis of the level of identification by the students of a particular semester, the nature of creativity and innovation activities in which they participated. Another area of analysis were areas where subjects belong, where students use their own ingenuity and creative thinking, as well as recognition of the type of support provided to students by the university in the development of creativity and inventiveness.

Analysis and interpretation of study results. Currently, a key element of the future of higher education is to improve the education quality and to better align competencies of graduates to the job market requirements [6]. Therefore, it is important to verify the requirements of the labour market in relation to competence and skills of new employees.In this article the author presented the results of analysis carried out on the basis of primary and secondary research (figure 1).

Secondary research. A comparative analysis on the reports on the first steps in the labour market was conducted by Deloitte Poland [7, 8, 22–26] and the development of Human Capital for 2020 proposed by the European Strategic Framework for Education and Training [27] and the Ministry of Labour and Social Policy [MPiPS 2013]. It checked the demand for skills and qualifications in the labour market in relation to what universities' offers in the field of production engineering.

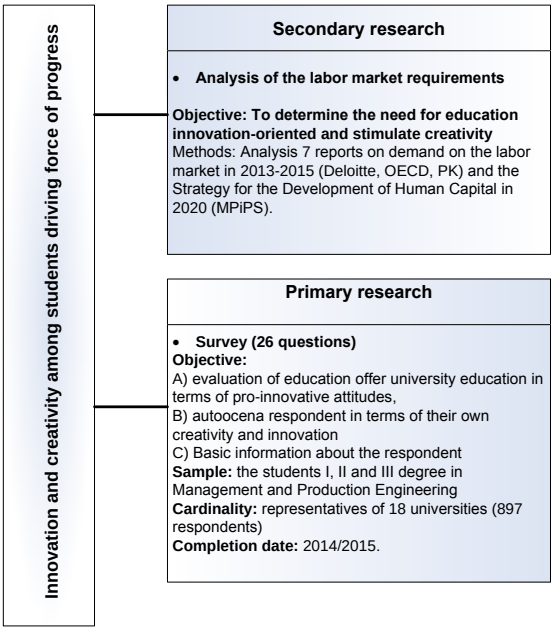

Fig. 1. Diagram of the study

Analysis of seven reports with matter of demand on the labor market in 2013––2015 (Deloitte, OECD, PK, PARP) and the Strategy for the Development of Human Capital in 2020 (Ministry of Labour and Social Policy), showed above all the needs of individuals with such properties:

- young people with great potential for the future, having not only competent, but also predispositions leadership, which in the future will allow them to take up leadership positions in the organization,
- persons assigned leadership roles in business with strategic thinking skills, charisma and ability to inspire others,
- having the ability to work in a group and effectively learn new things,
- being able to solve problems, characterized by creativity, entrepreneurship and showing initiative,
- self-organizing work and characterized by independence in decision-making,
- resistant to stress, taking care of your self-development and experts in their field.

Primary research. The search for a model approach for education which develop creativity and innovation among students of ZiIP was carried out from two perspectives. The first from the student perspective – opinions used estimate:

- educational offer in terms of content related to creativity and
- innovation which form pro innovative attitudes of students,
- fields to which subjects which favour students using their own creativity belong,
- noticing and rewarding of students by the university (lecturers)
- for their creativity and innovation in thinking,
- support for inventions carried out by the students.

On the other hand, in the second perspective – following data were used:

- the diversity of forms of support inventiveness of students,
- numbers of innovative and creative subjects implemented (relative to the total number of subjects and hourly count).
- creativity of teachers.

From the perspective of the student the best conditions for the development of creativity and innovation were provided by university F. Over 50% of respondents from the first semester have the opportunity to participate in classes of innovative and creative character. What is worrying is that 58% of students in semester 1 at university A do not find in the ongoing content of subjects aspects of innovation and creativity. The percentage of students in remaining 4 universities who noted the effects of education (creativity and innovation) subjects carried in semester 1 is similar, consisting of slightly over 40% of the population.

Analyzing the same research problem among students of semester VII, the highest percentage of students who saw in the studied subjects the potential of innovation and creativity was identified at university D (82%), university A (75%). It is worth noting that awareness of participation in the activities which develop innovative and creative thinking increases with the kind of „experience of study" – a higher semester of study (university D, A). It can be assumed that in this case the perspective of writing engineering work, getting professional work, prompts greater interest/readiness of students in the activities of innovative and creative character.

It is interesting to know whether there is a relationship between consciousness of participation in the activities of innovative and creative and use in the frame of activities their own innovation and creativity. Fig. 2 summarizes the responses of students in the last semester of all universities participating in the study (except university A – semester V). The question was a semi-open one. The students were asked to choose from the 'kafeteria' in these areas, where classes required, and also encouraged the use of self-innovation and creativity. The question had the character of multiple choice- answers do not add up to 100%.

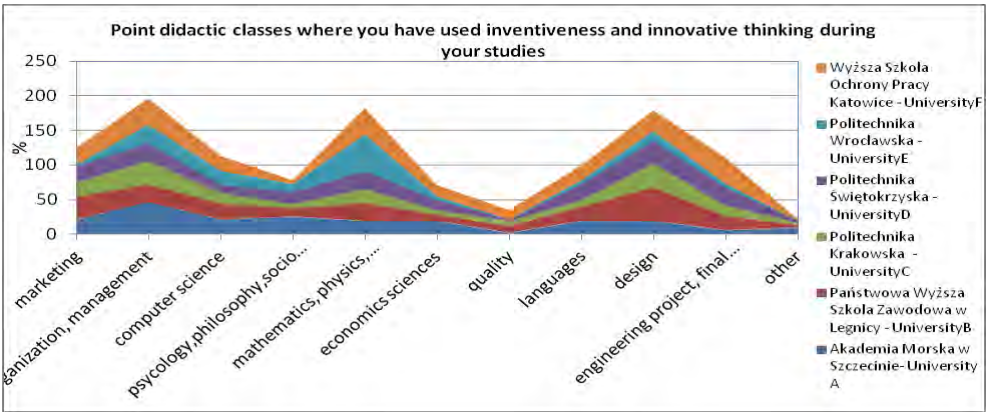

Fig. 2. Areas of activities, which ingenuity and creative thinking, as indicated by the students of VII semester are used

The clear leader among university students which stimulate students into creative thinking and action is university C. Interestingly, students of all universities participating in the survey indicated the same order of subjects favouring the use of their creative potential: engineering project, design, marketing, organization and management.

They differ, however, by the percentage of people identifying the role of different classes in launching their own creativity and innovation.

Interestingly, the weaker indications of innovation and creativity were obtained from subjects related to the areas of quality, mathematics and physics, computer science and information systems, psychology and philosophy and foreign languages. The block of economic subjects was assessed as the weakest. Student ratings of individual universities vary (in some cases quite significantly). It is important to seek the reasons for this, not only in content, but also methodical and deductible teaching activities at various universities. This will be the subject of a separate study.

Seeking to answer the question, what kind of support do the universities use to stimulate inventiveness (Fig. 3) established that scientific research group are essential for prompting the creativity of students. Of course, the percentage of students who notice the role of research groups in this area is different in different universities. 74% of students gave university D the highest readings followed by University E 68%, university F (38%), C (37%), B (32%), A (27%). Other forms of support such as conferences (publications), protection of intellectual property, financing costs of participation in the research, materials, costs of commuting, are of marginal importance. The exception is university E, in which 18% of students enrolled in study indicated the possibility of financing the costs of participation in research, materials, travel costs.

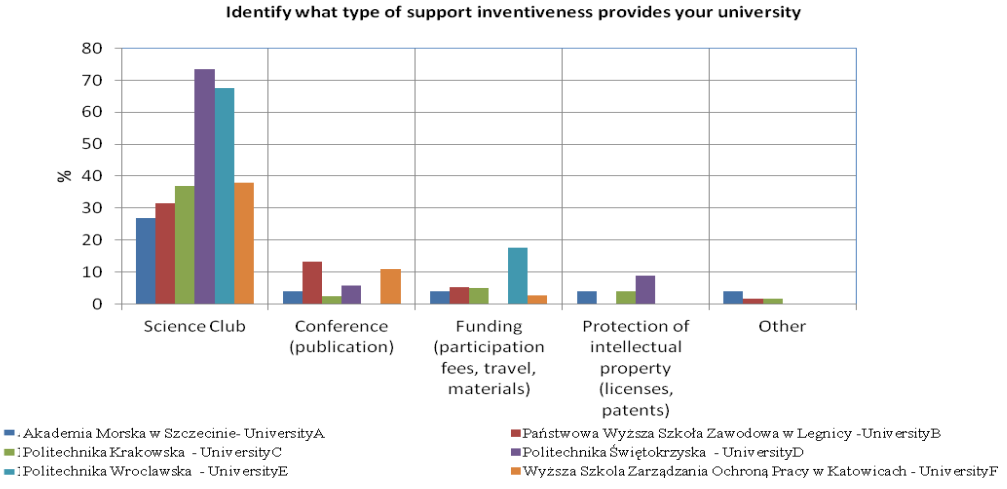

Fig. 3. Student opinions on the type of support provided by the university inventions

The above-mentioned organizational solutions of organisational nature used in six Polish technical universities in the fields of ZiIP – rewarding students for creativity

and innovation in thinking and various forms of support of inventiveness is important for students of this specialisation, but not the main source of formation of pro–innovative attitudes. The main area in which this type of attitude should be formed and developed are the main subjects in the plan of study.

On the basis of the plan of studies of individual universities – participants in the study were isolated subjects whose names suggest their innovative and creative nature (eg. The innovative production technologies, the development of an innovative product, project management, modern production technologies, prototyping new products, base management innovation, management innovation project, innovation in technology, the risk of innovative projects and investments and legal aspects of innovation).

On the basis of information obtained from the study plan the ZiIP, it was confirmed that universities enjoy considerable freedom in the design of the study plan, including determining the form and dimension of the hourly particular subjects. Information from the compiled tables shows that engineering studies: the university A subjects included in the group of innovation and creativity constitute 13.8% of all classes in this specialization, and by the amount of hours account for 15.2% of all classes. The second position is the offer of university D, whose offer for subjects on creativity and innovation represents 9.3% of the total number of classes, and amount of hours account to 6.8%. University C is respectively at 4.9% and 4.3% for innovation and creative activities.

The analysis shows that the university A – is a leader in terms of number of active specialized subject dedicated to the pro-innovation attitudes, conducted in groups. This is proved by the higher percentage of hours set for these activities in relation to the number of subjects in this category. Undoubtedly, – formation of pro–innovative attitudes of students towards the ZiIP, is conditioned on the one hand by the diversity and hourly dimension subjects specifically dedicated to creativity and innovation. On the other hand, it depends on the willingness of teachers from other specialties to stimulate creativity and innovation of students. It was agreed that half of the students university D, acknowledge creative teaching staff in conducting classes. In the case of students of university F, C, B the figure is 43%, 41%, 40% respectively.

The high percentage of students who do not have an opinion about both the creativity of its teaching staff is worrying, as well as whether university teachers reward students for creativity and innovation [10]. The conclusion is that students are not aware of the innovative and creative nature of tools and methods used in the education process on the ZiIP. The survey results suggest that a creative teacher has a greater ability to shape the characteristics of their students.

Summary. The undertaken research topic allows for the identification of factors that contribute to the formation of pro-innovation attitudes students of Management and Production Engineering. It was agreed that greater awareness of creativity, the ability to detect the creative elements in classes attended by students, is characterized by respondents with higher semesters. Undoubtedly the prospect of writing engineering work, getting professional work, prompts more conscious attitudes of students – participants of the creative learning process.

It should be noted however, that small classes (higher percentage of innovative activities in relation to the total number of hours than the number of subjects of an innovative nature) significantly affect the level of awareness of students about the innovative nature of the learning process in which they participate. The level of creativity of students increased in the universities, whose support for the inventiveness is clearly identified by the students. The survey shows that the main source of support inventiveness of students classes in scientific and creative staff. Analyzing the market for students, in terms of stimulating their creativity at the university, attention should be paid to other barriers that could restrict their creativity. These are barriers at the human level (eg. self-limiting beliefs), or at the business level (eg. the organizational culture, management style, unjust criticism, bullying, work under pressure and work overload). Often, performing creative tasks in the classroom or training does not make one automatically be creative at work, because one then returns to his worldview and opinion about oneself or colleagues. Sometimes, to unlock creativity, change is needed to on a much deeper level (eg. the level of values, beliefs, relationships, respect for oneself and others).

Reduced impact on creativity may have mental and psychosocial barriers. Creativity is also destroyed at offices and corporations, which usually impose uniformity not only in dress codes but also in thought and action. In addition, the creativity of employees reduces the chance for any errors, yet one cannot be creative without taking risks. Not every idea turns out successfully. So if a company or boss expects the same success, it causes employees to take a conservative stance and to stick to the same patterns. Fortunately, more and more companies (not only in the sector of new technologies) allow employees to devote part of their time to experiment, and even gives micro grants for internal research and testing of new solutions.

Disruptive influence in searching for the best solutions and looking at the problem from a wide perspective also has a syndrome of the group thinking. The syndrome works in such that some people working in a team pressure the group, suppresses its own opinions/ideas and adopt a conformist attitude. This self-censorship can be with one's awareness (eg. I will not say that I have a different opinion, because the boss can take my bonus or because the team will not like me) or without one's awareness (eg. when it seems to us, that we share the opinion groups, but in reality we destroy our own opinions right from the beginning and match to the opinion of the group considering it as our own).

To be creative, one should also broadly take care of their well-being, have an optimistic approach to life and focus on opportunities, not on the risks and hazards. As Frank Zappa said: „The mind is like a parachute. It does not work if it is not open".

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dr inż. Anna KIEŁBUS
Politechnika Krakowska
kielbus@pk.edu