ISSN 1822–8402 EUROPEAN INTEGRATION STUDIES. 2013. No. 7

THE ROLE OF EDUCATION FOR SUSTAINABLE DEVELOPMENT IN FOSTERING STUDENTS' INNOVATIVENESS AT TECHNICAL UNIVERSITIES

Jurate Cerneviciute, Ruta Petkute
Vilnius Gediminas Technical University, Lithuania
e-mail:jurate.cerneviciute@vgtu.lt
e-mail: ruta.petkute@vgtu.lt

crossref http://dx.doi.org/10.5755/j01.eis.0.7.4143

The transition from postindustrialism to knowledge-based economy requires a fundamental transformation of education system. Therefore, in the last decade, national governments and education institutions have been challenged by new demands set by the European Union and UNESCO to re-orient a traditional disciplinary paradigm of education towards Education for Sustainable Development (ESD). It is a more contextualized approach to education, which seeks to systematically and innovatively address complex socio-economic and environmental issues of a contemporary globalized society. ESD relies on a joined-up and cross-discipline thinking and practice which serves to uniquely and creatively configurate ideas from different fields. Thus, the new paradigm of education recognizes the importance of developing innovative and creative thinking of learners, as well as a strong interrelation between sustainable development and innovation.

The current paper aims to identify the role of ESD in fostering innovativeness of students from different engineering fields at technical universities. Moreover, it seeks to reconsider the concepts of innovativeness and creative thinking in terms of a new paradigm of knowledge. It also questions whether teachers' and students's attitudes toward these competences could possibly have some effects on developing them in students. Finally, it seeks to check a hypothesis that there is a correlation between lecturers' attitudes toward students' creative capabilities and students' self-evaluation.

The relevance of the research lies in the fact that in the face of local and global challenges, universities are reluctant or slow to transform the traditional paradigm of education into a new one. There is a lack of consistency in implementing the principles of ESD in curricula of universities. Very often technical universities show inadequate attention to interdisciplinary and context-specific model of learning as well as such general purpose competences as innovativeness and creative thinking. This threatens universities to become technocratic institutions.

The present study employs qualitative descriptive and explanatory research methods. An extensive research and a critical evaluation of international and Lithuanian literature on the field have been done in order to offer the current perspective on the issue. What is more, a pilot survey on the students of Lithuanian technical universities supplementes the qualitative research by providing with their opinions on the issue. The results of a theoretical study points out to some limitations of a traditional disciplinary paradigm which fails to foster students' creativity and innovativeness at technical universities at their full potential. Similarly, the findings of the students' survey support the results of the qualitative study. However, they also reveal a significant potential of ESD to spawn these general purpose competences, which, in a long-term, could contribute to sustainable development at the national and global levels.

Keywords: *sustainable development, education for sustainable development, cross-disciplinarity, innovativeness, creative thinking, technical universities, knowledge-based economy, knowledge society.*

Introduction

Recently, an international community has been continuously trying to deal with long-term consequences of the industrial revolution, which relied on a mass exploitation and heavy dependency on non-renewable energy resources. It has been admitted that in order to achieve sustainable development, the traditional model of economic thinking and practice has to be challenged. Therefore, the European Union and UNESCO have introduced *the EU Sustainable Development strategy* (EU SDS) which is aimed at managing the transitional process.

As any social reorientation, the transitional process towards sustainability, first of all, has to include reorientation of education. UNESCO acknowledges that "education needs to be central to personal, community, social, national and global development" (UNESCO, 2010). Thus, *Education for Sustainable development* (ESD) has been attributed a very prominent role in achieving the goals of the EU SDS. ESD proclaims that education systems must reflect transformative imperatives imposed by changing conditions of the times. Therefore, it stresses globalization as a very important factor to be considered when adjusting existing education systems and practices to respond to the demands of knowledge society.

The present study focuses on technical education as a very important determinant of economic transformation within the framework of EU SDS. Technical universities have a very significant potential in contributing to socioeconomic benefits in society. Thus it is very important to harness

technical education at its full potential in order to stimulate the development of various parts of the economy.

Reorientation of technical education requires redefining the roles of technical universities as well as rethinking students' competences which are to be developed to build capacities in sustainable technology and innovation worldwide. This involves development of students' ability to systematically address economic, environmental and social concerns in order to manage the transition. Thus, in the light of ESD, cross-disciplinary and context-specific approaches to learning become inseparable part of technical education. It offers efficient means to foster innovativeness of students of technical universities, which in turn can contribute to the overall creation of sustainable innovation system and the welfare of society.

The objective of the present paper is to identify the role of ESD in stimulating innovativeness of students from different engineering fields at technical universities. It also aims to reconsider the concepts of innovativeness and creative thinking, as well as the role of technical universities in the light of a new paradigm of knowledge. Morever, the study seeks to check a hypothesis that there is a correlation between lecturers' attitudes toward students' creative capabilities and students' self-evaluation. In other words, the research hypothesizes that lecturers' treatment of students' creativity and innovativeness might in turn predetermine student's self-perception. Finally, the study aims to highlight the need for the improvement of higher technical education both at national and international levels.

The relevance of the present study, first of all, lies in the fact that despite significant achievements in infusing ESD into national education systems, unsustainable models of education still persist. For this reason, with the end of the United Nations Decade of Education for Sustainable Development (DESD), it becomes essential to review existing education policies and practices using an ESD perspective.

Moreover, the limitation of ESD integration into tradition model of education still exists due to the lack of consistency in this process. This is also the case when it comes to technical education. The perception of the three-domain model of sustainability is very often restricted to seeing it as a theoretical construct, the constituents of which co-existing autonomously rather than overlapping with each other to provide a unique holistic view to solving existing practical problems. The main contribution of the present paper lies in the fact that it highlights a huge potential of ESD in technical education to release creativity and innovativeness of students at technical universities. However, technical universities are reluctant or slow to transform the traditional paradigm of education into a new one. Thus, they might be threatened to become technocratic institutions which do not suit the dynamics of a contemporary world.

Research methods employed in the study include qualitative descriptive and explanatory research methods, which draw on a thorough analysis of international and Lithuanian theoretical literature, research materials, official documents as well as methodological references related to the subject in question. What is more, students' survey supplementes the qualitative research. It is important to stress that this survey is a pilot research which ads to the overall qualitative study by providing with students opinions on the the way their lecturers' see their creative capabilities, as well as their own self-evaluation of their creativity. The present research could be furthered in the future to collect more quantitative data.

On the Notion of Sustainable Development

In the late 20th century, a rising public awareness called for a worldwide debate on an urgent need to shift the traditional model of growth toward a more sustainable approach to societal and economic development. Consequently, this led to the introduction of the concept of *sustainable development* (SD), which has become a fundamental objective and strategy of the European Union. Over the years, there have been many attempts to define the concept of SD. However, the definition of the United Nations still is the most widely recognized definition of SD. It suggests that SD is "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Our Common Future, 1987).

In general, the concept of SD, as elaborated by the Outcome Document of Johannesburg World Summit on Sustainable Development (2002) as well as reflected in the EU Sustainable Development Strategy (EU SDS), promotes the three fundamental objectives – environmental, economical, and societal developments. The three-pillar model suggests that the environment domain deals with the impact of technological development on the environment and human lives. The economy domain concerns with the impact on local, national and international economies. The society domain investigates the way people's lives are affected.

Even though the three spheres of concern are brought under distinct categories, at the same time, they are to be perceived as overlapping and interdependent rather than autonomous constituents. A common limitation of understanding SD lies in the fact that not all of these three standards of sustainability are taken into account to determine whether something is sustainable. Very often, SD is conceived from environmental perspective only while underestimating socio-economic dimensions of it. However, the complexity of the concept of SD requires systems thinking which views economic, environmental, and social domains as mutually reinforcing each other.

It is very important to stress that the concept of SD must be constantly reconsidered and supplemented to meet the demands of times. This is due to the dynamic nature of the notion of development in general. Therefore it could be asserted that SD is not a static fixed notion but rather an ongoing process in a dynamic world where conditions of the three domains are constantly changing. For instance, more recently, it has been suggested that the three-pillar notion of sustainable development should be elaborated to incorporate the fourth dimension of culture, which strongly correlates with the society domain. As a revised model phrases, "we are part of a system that connects individuals, their culture, their social and economic activities and their natural surroundings" (UNESCO, 2002b). The current elaborated concept of SD is an attempt to reflect an increasing political relevance of culture. It will gradually shift from a marginal sector of human activities to the key factor of development in general. The development of the knowledge-based society calls for the need to increase human resources.

Education for Sustainable Development as a New Educational Strategy in Knowledge society

The transition from postindustrialism to knowledge-based society, in which knowledge permeates all parts of economic life, leads to what is called a new paradigm of knowledge production. It marks a shift from a traditional paradigm of knowledge, which is discipline-oriented and relying on the novelty of knowledge, to a context-specific paradigm of knowledge. According to A. Glosienė, the new paradigm of knowledge stresses the need to develop knowledge and competence which equip with capabilities to innovate and contextualize existing knowledge. Thus, knowledge production should be seen as a dynamic process which situates knowledge within location, context, and time. (Glosienė, 2010).

Education and learning in general have been increasingly recognized as crucial means of managing developmental transitions. However, in order to do this, traditional education systems must be questioned to ensure if their methods fit within transitional context. Education is not only expected to reflect the dynamics of the world and master the knowledge and competence of learners to manage it respectively, but also to transform society. "Schools today serve and shape a world in which there can be great economic opportunity and improvement if people can learn to work more flexibly, invest in their future financial security, reskill or relocate themselves as the economy shifts around them, and value working creatively and collaboratively" (Hargreaves, 2003: 1). Furthermore, it has been articulated that knowledge has become a new key resource of economic welfare.

Therefore, international societal organizations such as The World Bank, the United Nations, the European Union, and the OECD, "have placed knowledge and learning at center stage for future sustainable economic development" (Amidon, 2003:11). They have agreed upon the need for Education for Sustainable Development (ESD), which has a potent force in achieving SD. As a result, the World Summit on SD in Johannesburg put in place the United Nations Decade of Education for Sustainable Development (DESD), spanning from 2005-2014. Thus, the last decade has been a period of new demands on national governments and education institutions for they were urged to infuse the principles of ESD into national education policies.

Different organizations have expressed their perspectives on what ESD is about. President's Council on SD provides the following definition of education for sustainability: "A lifelong learning process that leads to an informed and involved citizenry having the creative problem-solving skills, scientific and social literacy, and commitment to engage in responsible individual and cooperative actions. These actions will help to ensure an environmentally sound and economically prosperous future" (President's Council on Sustainable Development, 1993). In general, the key role of ESD is to integrate the concepts of SD into education and public awareness at all levels and all sectors of society.

As Education for Sustainable Development in Action Learning & Training Tool puts it, ESD corresponds to the three-pillar model of SD and promotes transformative learning which is oriented towards complex developmental processes. Thus, ESD "emphasizes creative and critical approaches, long term thinking, innovation and empowerment for dealing with uncertainty and for solving complex problems". It offers a coherent framework for a new paradigm of thinking and learning, questioning a traditional discipline-based model of education which is unable to systematically respond to change. ESD promotes contextual and cross-disciplinary approaches to education as efficient means of reorienting university/school curriculum towards sustainability. What is more, in order to come up with a non-traditional approach to tackling transitional challenges, ESD calls for reconsideration and elaboration of a traditional set of competences to be developed by learners. It names creative and critical thinking, complex problem solving, skills of investigation as well as envisioning alternative futures as necessary new competences needed to deal with the complexity of sustainable development (UNESCO, 2010).

As the DESD is approaching to the end, national governments and education institutions have been urged both to implement the principles of SD into education policies as well as reflect on the results of ongoing process of implementation, its impact and remaining challenges. It is important to note that the limitation of ESD integration into tradition model of education and its evaluation lies in a number of reasons. First of all, due to its dynamic nature, ESD undergoes constant alterations and improvement processes. Therefore, there are no static ESD indicators to be evaluated. In addition to this, there is a lack of consistency in ESD integration into traditional education paradigms. In the case of Lithuanian education system, the implementation process is even slower and more fragmented given the fact that Lithuanian culture is still suffering from the consequences of long-lived isolation caused by the post-communist transition period. Thus, it could be assumed that Lithuania has been facing more difficulty while breaking away from standardized models of education than Western countries. In Lithuania, there is an immense gap between theory and practice which must be filled in when it comes to implementation of ESD at its full potential. However, in the last decade, ESD has been increasingly acknowledged as a significant contributor to a higher education quality and relevance, and its enormous potential in Lithuania has been recognized by policymakers as well as practitioners.

Technical Universities in the Transitional Context

In the last decades, the speed and scale of transformative leaps across the globe have gained a momentum. When dealing with change, science, technology and innovation have become inseparable constituents of the overall strategy of SD.

First of all, it should be stated that technology might have both positive and negative effects on society and living environment. On the one hand, technology might leave a deep ecological footprint in the planet. On the other hand, it might come up with actual tools to manage the transition, e.g. a new smart technology can contribute to the transformation to low-carbon economies. What is more, technological innovation adds to the long-term economic growth. In other words, technological innovation has a potential to do both threaten and actually reinforce sustainable development. Thus, one of the targets of the UN Millennium Development Goals set in the UN Millennium Summit in 2000 is to make available the benefits of new technologies as they will have significant impact on long-term economic transformation and

achievement of the Goals (Juma and Yee-Cheong, 2005). In general, technological development is a prerequisite for much of the improvement in human welfare.

It could be asserted that technical innovations, which largely are products of graduates from technical universities, play a significant role sustaining economic growth. As Juma et al. suggest, "Development trends around the world need to be reviewed to evaluate the role that science, technology, and innovation play in economic transformation in particular and sustainable development in general" (Juma et al., 2001). Consequently, UN Millennium Development Goals states that "higher education is increasingly being recognized as a critical aspect of the development process, especially with the growing awareness of the role of science, technology, and innovation in economic renewal" (Juma and Yee-Cheong, 2005:89). The need to invest in science and technological education in order to transform economy and society is strongly spelled out.

In the light of ESD, it becomes important to rethink the role of technical universities. Traditionally, governments and higher education institutions have seen technical universities as educational institutions which aim to build specialized technological knowledge and competence. However, within the new paradigm of knowledge, they are criticized for being overly narrow in their functional perspective and concentrating on a mere technological development as it threatens universities to become technocratic institutions. According to UN Millennium Development Goals, technical universities lack the perception of being developmental partners, therefore, "universities throughout the world are undergoing reform seeking new models to address challenges of sustainable development" (Juma and Yee-Cheong, 2005:96). The process of reorienting conventional paradigm of education toward a new one has already begun.

In fact, ESD provides a foundation for a new model for technological learning because of its focus on three-pillar model of sustainable development and interdisciplinarity as a means to approach different mutually interrelated spheres of life. This allows for contextualization of technical knowledge and competence. As UN Millennium Development Goals puts it, "technological learning involves bringing together a wide variety of disciplines, research cultures, and traditions" (Juma and Yee-Cheong, 2005:43). This means that the boundaries in between different disciplines are merging. Moreover, it is claimed that social sciences play a significant role in the overall technical education, as they help to view, understand the source, modes of creation, and impact of science and technology in the proper context. However, universities, and especially technical universities, underestimate interdisciplinary approach as a key strategy to develop and contextualize students' knowledge and competence. Instead, they rely on specialized knowledge which blocks the development of a cross-disciplinary holistic view. UN Millennium Development Goals maintains that "The biggest obstacle of cross-sectoral learning is the narrow specialization that characterizes the search and application of knowledge" (Juma and Yee-Cheong, 2005:44). Technical universities are expected to draw on a comprehensive model which views technological advances and innovation as an indispensible part of the overall national or global strategy of SD. This perspective to technical learning, in turn, calls for the development of a new set of knowledge and competence which could trigger students' joined-up and innovative thinking.

The Role of ESD in Fostering Innovativeness in Engineering Students

When discussing technological innovation as a driving force of development in the knowledge society, the need to acknowledge significance of such competences as creative and innovative thinking becomes vital. Recently, the link between human's creative power and economic benefit has started to be articulated more strongly. E. Soja claims that the domain of economy has been witnessing 'cultural turn', which marks a clear articulation of the importance of culture and creativity in this new era (Soja, 1999). This is also maintained in the Decision of European Parliament and the Council concerning the European Year of Creativity and Innovation (2009). It is said that in order to respond to globalization and the shift to knowledge-based economies, Europe needs to enhance its capacity for creativity and innovation for social and economic reasons. It has been admitted that creativity and innovativeness have become a source of a competitive advantage in economy. As a result, creativity is not restricted to the field of art anymore, but is said to be a crucial constituent of any field to spawn developmental processes.

This goes along with the four c model of creativity by Kaufman et al. which draws a distinction between four different levels of creativity: mini-c (creativity which manifests in the learning process), little-c (everyday creativity which can be found nearly in every person), Pro-c (professional or expert creativity), and Big-C (eminent creativity which is a property of gifted people) (Kaufman et al., 2009). This model maintains that creativity is inherent in any everyday professional activities or learning process of any discipline.

This amounts to the statement that the development of creative and innovative thinking must be indispensible part of engineering study programmes at technical universities in order to contribute to the overall technical innovation system. According to A. Hargreaves, knowledge-society requires new competences such as innovativness and creativity and educational institutions have to efficiently correspond to this need by developing these qualities in learners; otherwise, their people and their nations will be left behind (Hargreaves, 2003). However, even though technical universities acknowledge a significant role of technical innovation in meeting the transitional challenges, they seldom consider purposeful development of students' innovative and creative thinking as part of innovation development strategy. Innovativeness and creative thinking is still taken for granted in curricula of technical universities and, thus, is not given sufficient significance.

As Ch. Bilton asserts, a narrow way of thinking about creativity is embedded in Western philosophies of art and reinforced through a standardized education system which suggests creativity to be an exclusive property of 'talented' individuals. He also adds that, "today 'creativity' is as likely to feature on the curriculum of an engineering or business course as in the arts: a creative thinker might be a banker or lawyer as well as a composer of photographer" (Bilton, 2007, 13-14).

Similarly, in order to promote new competences, the European Parliament and the Council assert that "Europe needs to strengthen its capacity for creativity and innovation for social and economic reasons in order to respond effectively to the development of the knowledge society: innovative capacity is closely linked with creativity as a personal attribute, and to be

harnessed to full advantage it needs to be widely disseminated throughout the population" (European Parliament and Council, 2009). There is an increasing need to articulate that many of technological innovations are the outcome of creative thinking and innovativeness. Thus, technical universities are expected to modify their traditional curricula to make sure that creativity is mainstreamed in all disciplines.

ESD could serve as a baseline for revealing students' innovativeness in engineering study programmes. This is due the fact that ESD relies on a joined-up and cross-discipline thinking and practice which encourages creative combination of ideas from different fields. Also, ESD fits within a new paradigm of knowledge production which breaks away from standardized discipline-oriented knowledge and competence as well as established solutions to problems. Instead, ESD turns to a new paradigm of knowledge production which offers a context-specific model of learning. This model views creativity as capability of problem solving and contextualization of knowledge within location, context and time.

When it comes to competence building in engineering education, ESD offers a comprehensive model which, first of all, enables students to position themselves within a global developmental process and understand its dynamic nature. It makes students aware of the fact that their knowledge and competence is developed to innovatively tackle the challenges of change, which requires constant learning and unique approaches to ever-changing conditions of a rapidly globalizing world. This also provides students with understanding that technological improvements which are to be done must be of the upmost relevance and meet societal demands of time. Second, a cross-disciplinary model of learning helps students to have a wider and more systematic look at economic, social and environmental concerns. Thinking in terms of interrelations and systems stimulates students' creative and innovative thinking as they are required to offer creative configurations of knowledge from different fields and come up with innovative solutions and alternative options to complex practical problems. This also adds to students' understanding of the source, modes of creation, and impact of science and technology on society and environment in relation to sustainable development principles and practices which in turn leads to creative and smart improvements of existing technologies.

First of all, in pursuit of nurturing creativity and innovativeness in engineering students, the need for technical universities to spawn students' innovativeness should be clearly spelled out. In addition to this, the inherent shortcomings and potential of traditional engineering study programmes to stimulate students' innovativeness should be articulated. Finally, a holistic scheme for developing students'competences of this kind should be drawn. It is important to note that the present study does not offer to supplement existing engineering study programmes by additional courses on creativity and innovativeness but rather infuse the principles of ESD into existing disciplines which simultaneously would ensure that students do comprehend the way innovativeness and creativity could add to any subject area. In other words, every discipline taught in an engineering study programme should integrate innovative ESD educational methods and materials, based on cross-disciplinary approach and contextualization of knowledge, to foster creativity and innovativeness in future engineers. In order to achieve this, policymakers, educational institutions and practitioners have to work collaboratively to infuse the principles of ESD into conventional university curricula, and in this way, add to sustainable development at national and international levels.

Results of Students' Survey

The survey is aimed to provide with responses from students to find out their opinions on the importance of developing innovativeness in students from engineering study programmes at technical universities.

The research population represents first-year undergraduate students from different engineering study programmes at two Lithuanian technical universities. For the present research, a nonprobabilistic sampling method has been chosen. There were 57 students from Vilnius Gediminas Technical University, the Faculty of Electronics, and 30 students from Kaunas University of Technology, the Faculty of Telecommunications and Electronics, who took part in the survey, which was administred in 2013 from March to April. The survey included forced-choice answers 'yes', 'no' and 'partly'. The questions and count for responses are represented in Table 1.

Table 1. Students' responses to foced-choice questions (source:authors)

Questions	Forced-Choice Answers & Count for Responses		
	Yes	**No**	**Partly**
1. Can fulfillment of a daily study assignment be creative?	30%	18%	52%
2 Are you motivated to fulfill daily study tasks creatively?	10%	50%	40%
3. Should engineering studies foster students' innovativeness?	68%	9%	23%
4. Do disciplines taught in your engineering study programme provide you with opportunities to reveal your innovativeness?	20%	39%	41%
5. Is innovativeness and creativity indispensible part of your studies and future profession?	51%	18%	31%
6. Do disciplines taught in your engineering study programme provide you with enough opportunities to contextualize your knowledge?	26%	20%	54%
7. Can cross-disciplinary approach to learning spawn your innovativeness?	44%	18 %	38 %
8. Do disciplines taught in your engineering study programme provide you with opportunities to analyze different phenomena and processes from cross-disciplinary approach?	22%	20%	58 %
9 Do disciplines taught in your engineering study programmes introduce you with the interrelation between social, economic, and environmental phenomena and processes which is the basis for sustainable development?	24%	30%	46%

As can be seen from Table 1, 30 % of students think the fulfillment of daily study assignments can be creative. What is more, only 10 % admit to be motivated to fulfill daily study tasks creatively, whereas half of the students said they are not motivated to do this at all.

It is important to note that the majority of students (68 %) believe that engineering studies should foster students' innovativeness. Futhermore, half of the students (51 %) think that innovativeness and creativity is indispensible part of their studies and future profession. Nevertheless, only 20 % assert that engineering studies do actually provide them with opportunities to reveal their innovativeness.

When asked if different disciplines taught in their engineering study programme provide them with enough opportunities to contextualize their knowledge, 26 % of students answered 'yes' to this question and a little bit more than half of the students (54 %) answered 'partly'.

Furthermore, cross-disciplinary approach to learning as a means to spawn innovativeness is seen by 44 % of respondents. Meanwhile, only 22 % say that disciplines taught at university actually provide them with opportunities to analyze different phenomena and processes from this approach and a little bit more than half of the respondens (58 %) say they are partly given this opportunity.

Finally, 24 % of students answered that different disciplines taught in their engineering study programmes familiarize them with the interrelation between social, economic, and environmental phenomena and processes which is the basis for sustainable development, whereas 46 % replyed to this question 'partly'.

What is more, students were asked to reflect on the way they understand their lecturers' attitudes toward their creativity as well as evaluate their own creativity in 5-point scale (see Chart 1).

As reflected in 5-points scale, students' average evaluation of lecturers' attitudes toward their creativity amounts to 2.4 points, whereas their own self-evaluation of their creative capabilities reaches 3.1. Furthermore, the correlation coefficient between students' understanding of their lecturers' attitudes toward their creativity and students' self-evaluation is 0.555.

To conclude the results of the survey, it could be said that there is a lack in students' understanding that fulfillment of any daily task could be creative process as it is suggested in four c model of creativity by Kaufman et al. It could be assumed that this underestimation of being creative in a daily learning process is predetermined by the fact that students feel unmotivated to fulfill study tasks creatively as the results of the survey revealed.

The results also show that even though many students think their engineering studies should stimulate their innovativeness, which is indispensible part of their studies and future professions, they also feel lack of opportunities to reveal their innovativeness and creativity in their studies. In addition to this, the responses of students show that engineering study programmes also may be lacking contextualized and cross-disciplinary approach to learning which lay the foundation for students' understanding of the principles of SD. Finally, the findings confirm the hypothesis that there is a correlation between students' understanding of their lecturers' attitudes toward their creativity and students' self-evaluation but the correlation is not strong. However, the average of students' self-evaluation of their creative capabilities is higher than the average of students' understanding of their lecturers' attitudes toward their creativity. Therefore, it could be assumed that students might feel undervalued in their creative capabilities by their lecturers.

Conclusions

The main theses of the present research could be concluded as following:

1. Since the 21st century marks a shift in the role of culture and knowledge in society, the recognition of a strong link between education and sustainability of economic growth becomes of a vital importance. Therefore, ESD has to be placed at the centre of sustainable development practices. It serves to move from conventional model of development, which relies on growth and exploitation of resources, to the system of sustainable development.
2. ESD corresponds to transformative imperatives of the time and constantly questions the traditional education

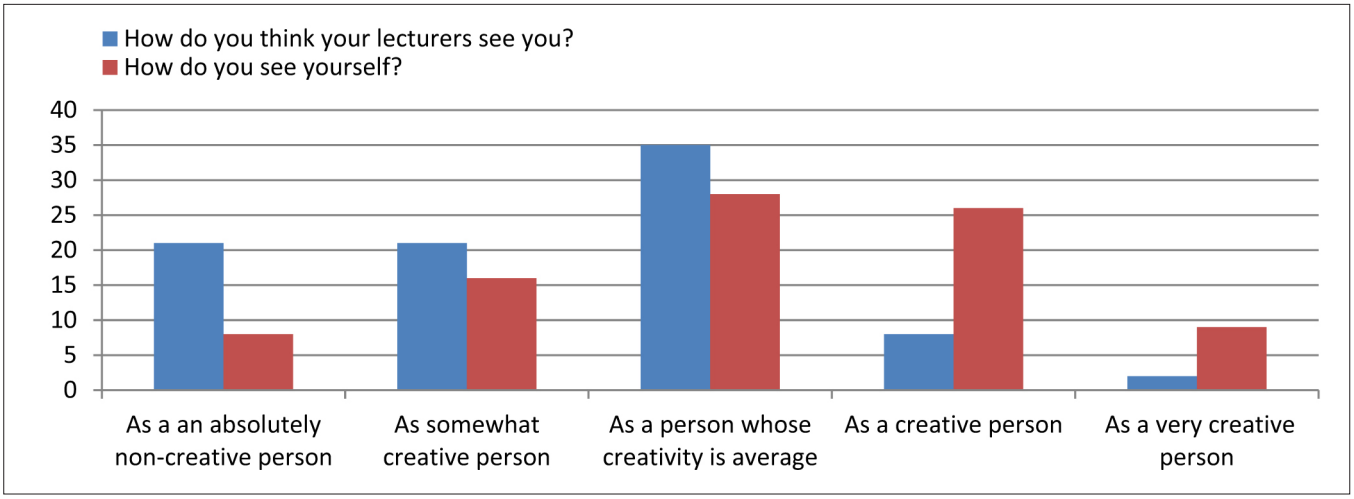

Chart 1: Students' understanding of their lecturers' attitudes toward their creativity and students' self-evaluation (source: authors)

paradigm, which has been criticized for being discipline-oriented, too static, and not responding to the complexity of a rapidly globalizing world. Meanwhile, ESD offers a cross-disciplinary and context-specific approach to learning which systematically takes account of complex economic, environmental and societal concerns into study programmes and teaching practices.

3. In the light of ESD, technical universities should rethink their role in developmental process and re-position themselves as active contributors to SD. However, technical universities are slow to infuse ESD into their curricula as they tend to focus on a mere technological improvement rather than developing a more holistic approach to technical education.
4. The application of a systematic integrated approach of ESD to technical education provides engineering students with plenty of opportunities to reveal their creativity and innovativeness as it calls for creative and unique ways of approaching the complexity of sustainable development process. These competences are closely linked to critical thinking, ability to contextualize knowledge and transgress traditional boundaries of disciplines, all of which lead to the development of innovation.
5. The findings of the Lithuanian engineering students' survey suggest that there is a lack in students' understanding that creativity is inherent in any learning process. Furthermore, they are not motivated to fulfill daily study tasks creatively. In general, students recognize creativity as indispensible part of their studies and future professions. However, according to them, they are neither provided with sufficient opportunities to reveal their innovativeness nor to contextualize their knowledge or develop a cross-disciplinary perspective. Finally, the results reveal a correlation between students' understanding of their lecturers' attitudes toward their creativity and students' self-evaluation but this correlation is not strong.What is more, students' responses show that they believe to be more creative than they are treated by their lecturers. Thus, assumption could be made that engineering study programmes at technical universities do not use all of their potential to encourage students as well as provide them with opportunities to demonstrate their spirit of innovation in daily study tasks. Consequently, students might feel undervalued by their lecturers as well as lack of motivation which negatively affects learning outcomes.
6. A purposeful adjustment of the traditional curricula, teaching methods, and materials needs to be made to develop innovativeness in engineering students as well as trigger their motivation and inclusion into learning process. This could also help to avoid technocentrism in technical universities and turn them into adaptable and competitive institutions in knowledge-based economy.

References

Amidon, D.M. (2003). *The Innovation Superhighway: Harnessing Intellectual Capital for Sustainable Collaborative Advantage*. Amsterdam: Butterworth Heinemann.

Bilton, Ch. (2007). *Management and Creativity: From Creative Industries to Creative Management*. Oxford: Blackwell Publishing.

Decision of the European Parliament and of the Council concerning the European Year of Creativity and Innovation. (2009). On-line paper: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:348:0115:0117:EN:PDF.

Education for Sustainable Development Lens: A Policy and Practice Review Tool. 2010. Paris: UNESCO.

European Commission. (2009). *Sustainable Development*. On-line paper: http://ec.europa.eu/environment/eussd.

Glosienė, A. (2010). *Kūrybiškumas ir socialinis kapitalas žinių visuomenėje: idėjų žemėlapis*. Vilnius: Vilniaus Universiteto leidykla.

Hargreaves, A. (2003). *Teaching in the knowledge Society. Education in the Age of Insecurity*. New York: Teachers College Press.

James C. Kaufman, J. C., Beghetto, R.A. (2009). "Beyond Big and Little: The Four C Model of Creativity". *Review of General Psychology*. Vol. 13, No. 1, 1–12. http://dx.doi.org/10.1037/a0013688

Juma, C., K., Fang, D. Honca, J. Huete-Perez, V. Konde, S. H. Lee, J. Arenas, A. Ivinson, H. Robinson and S. Singh. (2001). "Global governance of technology: meeting the needs of developing countries". *International Journal of Technology Management* 22(7/8): 629-655. http://dx.doi.org/10.1504/IJTM.2001.002982

Juma, C., L. Yee-Cheong. (2005). *Innovation: Applying knowledge in development. Achieving the Millennium Development Goals*. London: Earthscan.

President's Council on Sustainable Development. (1993). *Education for Sustainability: an Agenda for Action*. On-line paper: http://www.gcrio.org/edu/pcsd/ chap1.html.

Soja, E. (1999). "In different spaces: The cultural turn in urban and regional political economy." *European Planning Studies*. 7 (1). On-line paper: http://www-personal.umich.edu/~sdcamp/readings/Soja%201999.pdf.

Outcome Document of Johannesburg World Summit on Sustainable Development. (2002a). On-line paper: http://www.worldsummit2002.org/index.htm?http://www.worldsummit2002.org/guide/wssdoutcome.ht.

Our Common Future: Report of the World Commission on Environment and Development. (1987). On-line paper: http://www.un-documents.net/ocf-02.htm#I.

Education for Sustainability, From Rio to Johannesburg: Lessons Learnt from a Decade of Commitment. (2002b). Paris: UNESCO.

The article has been reviewed.
Received in April, 2013; accepted in September, 2013.