CASE STUDY ON SUSTAINABLE ENVIRONMENTAL BEHAVIOR IN ENGINEERING EDUCATION

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Abstract. The UNESCO document states that *Action for Climate Empowerment* is implemented through education, which has a crucial role to play in climate change, building capacities and attitudes for climate change mitigation, as well as stimulating and reinforcing understanding of, and attentiveness of climate change. A particular attention should be paid to engineering programmes, as engineers contribute to building a sustainable society, present and future, use resources efficiently and effectively, seek multiple views to solve sustainability challenges and manage the risk to minimise adverse impact on people or environment. In keeping with these principles, a primary objective of higher education engineering curricula is to produce graduates to be able to undertake engineering activities in a way that contributes to sustainable development. A case study was conducted at the Riga Technical University and the Latvia University of Life sciences and Technologies to assess the implementation of the UN Sustainable Development Goals (SDGs) in engineering studies, to assess the ecological intelligence of emerging professionals, and identify the measures to mitigate the effects of CO_2. The study includes several components that characterize sustainable attitude to environment: sustainable consumption, environmentally friendly transport, energy efficiency, zero-waste, etc. In total 194 engineering students took part in the study. The paper summarizes the results of a survey on sustainable environmental behavior. The results show that more than half of the respondents (52 %) say they have never heard of the SDGs, 43 % are confident in their ecological intelligence and 42 % say they may have. Although more than two thirds of the students (68 %) are aware of energy efficiency, only 25 % of the respondents carry out an energy audit of their home, etc. The article provides a full analysis of the research.

Keywords: CO_2 impact, ecological intelligence, engineering education, environment, Sustainable development goals.

Introduction

On 1 January 2016, the world officially began implementation of the 2030 Agenda for Sustainable Development – the transformative plan of action based on 17 Sustainable Development Goals (SGDs) – to address urgent global challenges over the next 15 years. It seeks to integrate and balance the three dimensions of sustainable development – economic, social and environmental – in a comprehensive global vision [1]. The Sustainable Development Goals – also known as SDGs or the Global Goals – are focused "to protect the planet from degradation, including through sustainable consumption and production, sustainable management of natural resources and by taking urgent action on climate change, so that the planet can support the needs of present and future generations" [2].

Reducing the output of greenhouse gas emissions is one of the most critical responses to climate change. The concentrations of greenhouse gases in the atmosphere have increased significantly due to human activities, such as combustion of fossil fuels etc. In the fight against climate change, the European Union (EU) has set greenhouse gas reduction targets for a number of economic sectors: industry, transport, agriculture, building, waste management etc. The EU's current target is to reduce its CO_2 emissions by 40 % by 2030 compared to 1990 levels, as well as to ensure climate neutrality by 2050 as a long-term climate target.

The sustainable development goal 13 "Climate Action" claims to take urgent action to combat climate change and its impacts [3]. Latvia's approach to achieving SDGs – contributions toward achieving sustainability by different stakeholders and the readiness of each individual to defend the rights of future generations are pivotal for successful outcomes [4]. According to the SDGs target 13.3: "Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning" [3]. The UNESCO document states that *Action for Climate Empowerment* is implemented through education, which has a crucial role to play in climate change, building capacities and attitudes for climate change mitigation, as well as stimulating and reinforcing understanding of, and attentiveness of climate change. Education, awareness-raising and public information play an essential role in increasing the capacity of communities to counter climate change and adapt to its impacts [5]. This document also states that climate change has to be included in school curriculums at all levels and across disciplines. A

particular attention shoul be paid to engineering programmes, as engineers contribute to building a sustainable society, present and future, use resources efficiently and effectively, seek multiple views to solve sustainability challenges and manage the risk to minimise adverse impact on people or environment [6]. In keeping with these principles, a primary objective of higher education engineering curricula is to produce graduates to be able to undertake engineering activities in a way that contributes to sustainable development.

In view of the above considerations, the purpose of the study is to find the ways how the United Nations (UN) Sustainable Development Goals are being pursued in engineering education, identify course(s) on sustainable development and theoretical or specialty subjects providing information about a sustainable approach to the environment. To implement *Action for Climate Empowerment* through education, the purpose of the study is to assess the ecological intelligence of emerging engineering professionals and to identify measures taken daily by students to reduce the impact of CO_2.

Materials and methods

This paper is the result of scientific analysis and assessment of scientific literature and a number of information sources, taking into consideration the author's reflection experience and observations in connection with the UN Sustainable Development Goals, Education for Sustainable Development (ESD), ecological intelligence etc. Ecological intelligence here is understood as an ability that lets us apply what we learn about how human activity impinges on ecosystems so as to do less harm and once again to live sustainably in our niche – these days the entire planet [7].

The study includes several components that characterize sustainable environmental behavior: sustainable consumption, environmentally friendly transport, energy efficiency, etc. In the study sustainable consumption is defined as "the term for the use of services and products in a way that corresponds to the basic needs, results in a better quality of life but, at the same time, it reduces the use of natural resources and toxic materials to the minimum, as well as the emission of waste and pollutants during the specific service or whole lifecycle of the specific product in order not to jeopardise the needs of future generations" [8]. While energy efficiency is based on the Environmental and Energy Study Institute description: Energy efficiency simply means using less energy to perform the same task – that is, eliminating energy waste. Energy efficiency brings a variety of benefits: reducing greenhouse gas emissions, reducing demand for energy imports, and lowering our costs on a household and economy-wide level [9]. Sustainable living is understood as a lifestyle that attempts to reduce an individual's or society's use of the Earth's natural resources and personal resources [10]. According to Winter M., practitioners of sustainable living often attempt to reduce their carbon footprint by altering methods of transportation, energy consumption and diet [11].

The empirical part of the research is based on the survey on environmental behavior of engineering students at the Latvia University of Life Sciences and Technologies (LLU) and the Riga Technical University (RTU). In total, 194 engineering students participated in the study, of which 31.4 % were from LLU and 68.6 % from RTU. It should be noted that the sample size in each institution is logical, taking into account the proportionality of the number of students. The aims of the survey were to reveal the views of students on sustainable develpment goals in their studies at university, assess the ecological intelligence of emerging engineering professionals and to identify measures taken daily by students to reduce the impact of CO_2. The questionnaire included different types of questions: (1) respondents were given several statements and asked to mark the correct option, (2) most of the answers to the questions were to be given by expressing approval or rejection on three types of the four-step Likert scale: *I have never heard of them/ I have heard about them/ know nothing about them/ not very familiar/ I am very familiar with them*; *yes/ no/ maybe/ I do not know* and *always/ usually/ seldom/ never*, etc., (3) open questions. The questionnaire (in Latvian) is available at: http://www.iipc.lv/surv/index.php/834593.

The study used the self-assessment method. According to Andrade H. & Valtchevs A., self-assessment is a process, during which students collect information about their own performance or progress; compare it to explicitly stated criteria, goals, or standards; and revise accordingly. The self-assessment method is seen as the most powerful means for tertiary education organisation to understand and improve its performance. The purposes of self-assessment are to identify areas of strength and weakness in one's work in order to make improvements and promote learning [12].

Results and discussion

Education is considered to be the most important transformative tool to resolve all the social, economic and environmental problems and a means to achieve the goal of sustainable development [13]. In order to achieve sustainable development goals, education must be reoriented to integrate education for sustainable developemnt (ESD) at all the stages. According to Nevin E., Education for Sustainable Development promotes the development of the knowledge, skills, understanding, values and actions required to create a sustainable world, which ensures environmental protection and conservation, promotes social equity and encourages economic sustainability [14].

The results show that in total only 2 % are very familiar with SDGs, while more than half of the respondents (52 %) have never heard of them (Fig. 1). Students were asked to name three SDGs. The vast majority could not do it. Here are just a few of the answers students identify as sustainable development goals: reduce non-renewable resources, protect the environment, reduce waste / recycle, protect the planet, economics. It should be noted that there are differences between the universities (Fig. 2). There are more students (54.7 %) at RTU, who have never heard of the sustainable development goals. 56.7 % of the respondents at LLU have heard about SDGs, but not very familiar with them, while only 43.6 % at RTU.

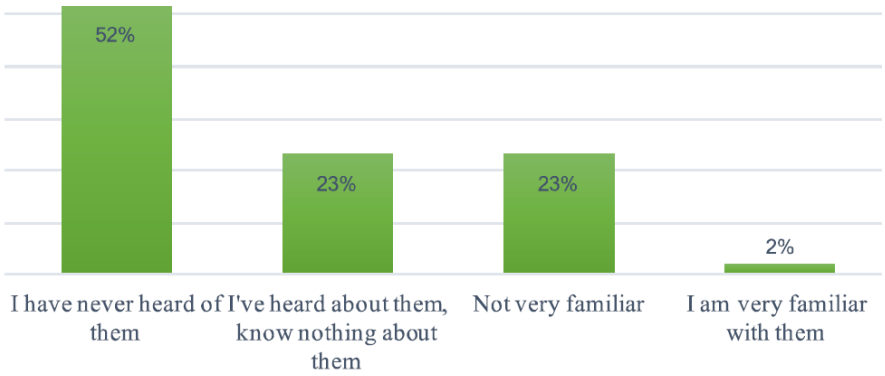

Fig. 1. **Are you aware of SDGs?**

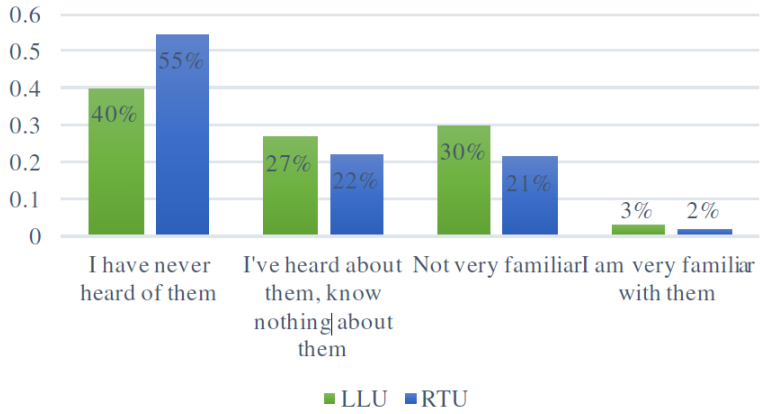

Fig. 2. **Differences between universities**

Students were asked, if their university program included a course(s) on sustainable development, to which two thirds of the respondents (65 %) answered negatively. More than 80 % of the surveyed students say that there are no courses in their study program that make them think about sustainable development or environmental issues. Only 18 % of the respondents can name specific theoretical or specialty subjects that have provided information on sustainability or sustainable environmental behavior.

The students were asked to make self-assessment of their ecological intelligence, as well assess their environmentally sustainable behavior, characterised by sustainable consumption, environmentally friendly transport, energy efficiency, sustainable lifestyle. As seen in Fig. 3, most students (72 %) are confident that they have the skills to lead a healthier life, but only 32 % promote

sustainable lifestyle. The vast majority of the respondents (68 %) are also aware of energy efficiency, while sustainable consumption is more or less problematic or unknown for 63 % of the students surveyed.

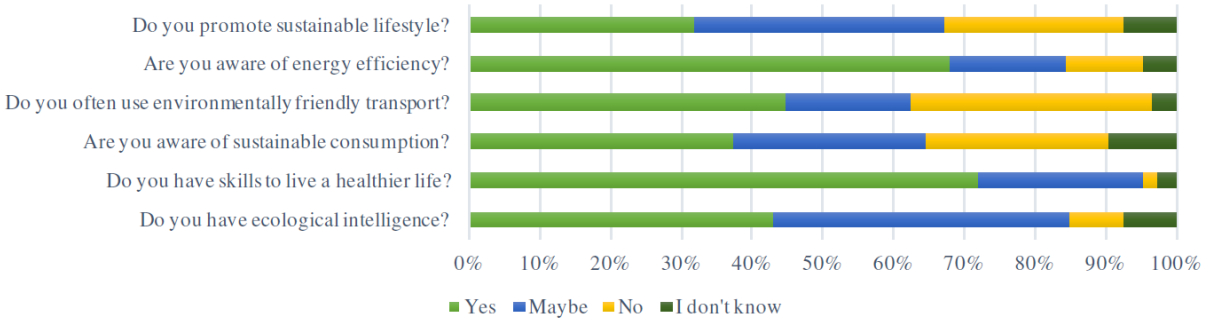

Fig. 3. **Students' self-esteem on sustainable environmental behavior**

It should be noted that there are no significant differences between the answers of the students, whose study programs include courses on sustainable development (Fig. 4), and those students, who do not have it (Fig. 5). In general, the students, who take such courses, are slightly more critical of their environmentally sustainable behavior.

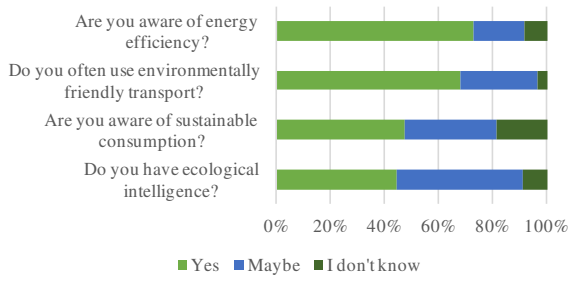

Fig. 4. **Answers if the university program has courses related to SD**

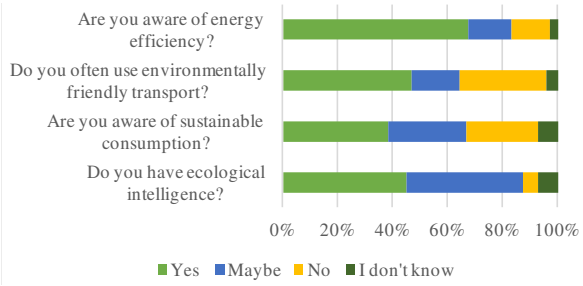

Fig. 5. **Answers if the university program does not include courses related to SD**

The term "greenhouse effect" refers to the way in which the Earth's infrared radiation is retained, causing the atmosphere warm. Solar energy reaches the Earth through the atmosphere and warms its surface. The stored energy then returns to the space in the form of an infrared stack. If this radiation is weaker than the incoming radiation and cannot overcome the specific barrier of atmospheric gases known as "greenhouse gases", the so-called "greenhouse effect" is created [15]. The most important greenhouse gas is carbon dioxide CO_2. According to several science-based studies, since the beginning of the industrial revolution, greenhouse gas emissions into the atmosphere have grown rapidly, mainly at the expense of CO_2 [15]. Therefore, reducing the output of greenhouse gas emissions is one of the most critical responses to climate change.

Students were asked about their habits related to CO_2 reduction (Fig. 6). A positive view of the situation is provided by the fact that the majority of the respondents (36 % always and 38 % usually) switch the lights off leaving the room and unplug the electronic devices, when they are not in use, as well as most – 37 % always, but 29 % usually – change incandescent light bulbs (which waste 90 percent of their energy as heat) to light emitting diodes (LEDs). However, 75 % (31 % seldom, 44 % never) of the respondents do not do energy audit of their home, therefore, it is not possible to identify the ways to be more energy efficient.

The lowest rates are related to the use of warm water. Only 38 % of the respondents have a habit to turn the water heater down and wash their clothing in colder water, 37 % – installing a low-flow showerhead, taking shorter showers.

Most respondents (28 % always, 37 % usually), bring own reusable bag when they shop. While only 43 % support and buy from companies that are environmentally responsible and sustainable, 59 % say they choose organic and local foods that are in season. More than half of the students (51 %) in daily activities try to reduce the food waste by planning meals ahead of time, freezing the excess and reusing leftovers.

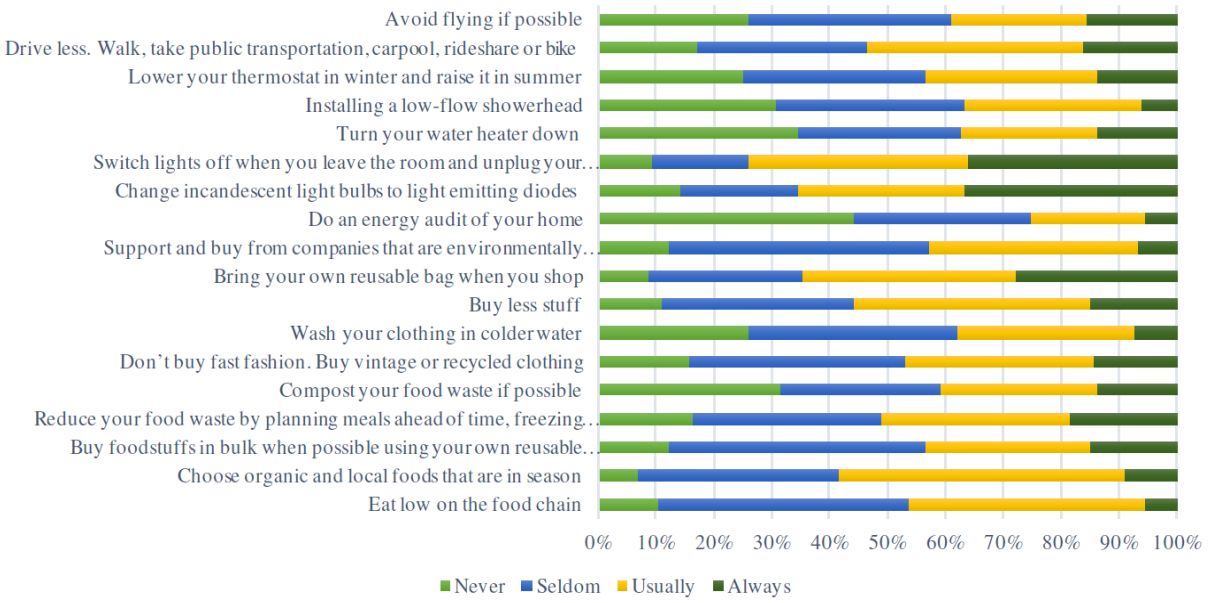

Fig. 6. **Students' self-assessment of habits reducing the impact of CO_2**

The results of the study show that there are differences between the answers of the students with ecological intelligence and without it (Fig. 7). For example, 76 % of those, who have assessed that they have ecological intelligence, always bring their own reusable bag when they shop, only 27 % of the students, who think they do not have ecological intelligence, do so.

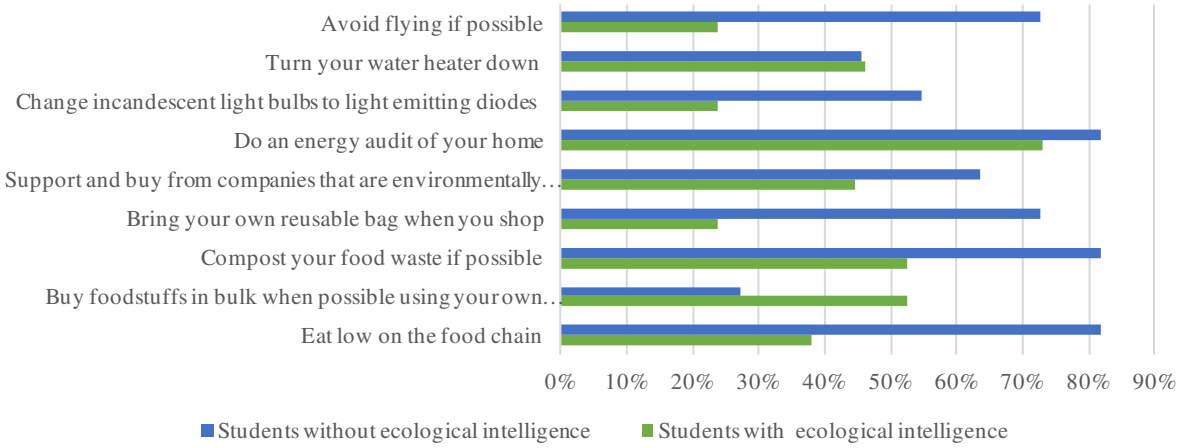

Fig.7. **Measures taken daily by students to reduce the impact of CO_2**

Evaluating the measures taken daily by students to reduce the impact of CO_2, the results of the study show that there is no significant difference between the responses of different universities' students.

Conclusions

1. There is a strong link between higher education and sustainability and the United Nations Sustainable Development Goals, as higher education promotes learning and training in order to acquire and update skills, knowledge and competences, in turn, SDGs are a global framework to tackle common challenges for development.
2. The engineering degree programs of the above mentioned universities include some courses related to sustainable development. Although information on sustainable and responsible attitude to the environment is also provided in some theoretical and specialty subjects, in total 52 % of the students have never heard of the sustainable development goals.
3. LLU students are more aware of sustainable development goals than RTU students.

4. According to several science-based studies, since the beginning of the industrial revolution, greenhouse gas emissions into the atmosphere have increased rapidly, mainly at the expense of CO_2 (carbon dioxide). Therefore, reducing the output of greenhouse gas emissions is one of the most critical responses to climate change.
5. Analysing the students' personal contribution to CO_2 emission reductions, they understand the harmful effects of CO_2 emissions on the atmosphere, but not all of the surveyed approve their personal contribution to reducing them.
6. Although 25 % of the respondents do not do energy audit of their home, they have good habits to switch the lights off leaving the room and unplug the electronic devices, when they are not in use, as well as to change incandescent light bulbs to light emitting diodes.
7. The students with ecological intelligence daily take more measures to reduce the impact of CO_2 than the students without ecological intelligence.
8. It should be noted that this was a case study, and it only reflects the views of the students who participated in it. Therefore, the results cannot be generalized, but only used to identify problems / directions for in-depth research.

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