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PEDAGOGY OF RETHINKING: TEACHING STUDENTS TO TRANSFORM CONVENTIONAL PROFESSIONAL PRACTICES TO SUSTAINABLE ONES

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Abstract. Sustainable development serves an umbrella concept for the transformation of individual and professional life. Students of higher educational institutions must acquire the skills of sustainable decision making and practicing, which will be applied in their working place. They might face problems in changing the existing professional practices to sustainable ones. The experience of ESD methods application in the universities of Ukraine, Poland, and Latvia was analysed in order to define common challenges and issues encountered by the supervisors of the courses, which included design of a project. The courses with projects were taught to the students of all three education levels with various backgrounds: Mechanical Engineering, Chemical Engineering, Environmental Engineering, Transport Technologies, and Management. The central idea of those projects was to transform chosen industrial and managerial practices to ones aligned with the SDGs. A self-assessment of course results, comparative analysis of methods and approaches used yield a list of recommendations and methods that contribute to the rethinking capacity for transformation of any professional field practices towards the principles of sustainability. In particular, it is clear that the project course should be co-created using transformative learning approach and "flipped classroom" to stimulate generation of students' ideas. Equally important is to adapt SDGs to each professional field not only highlighting their varied applicability but also conceptual equivalence. The important result of project-based learning is also action competence of students, being ready and interested to implement sustainability principles in their work and see them as options for entrepreneurship and business development.

Keywords*: Action competence, Project-based learning, Principles of Sustainability, Teaching methods, Transformative learning.*

JEL Classification: Q56

INTRODUCTION

The world is limited in terms of resources in all dimensions and allocation of the niches for population growth and economic development turns to be a problem without principles of sustainability. Education for Sustainable Development (ESD) has recently become an essential part of higher education in almost all science areas in the Baltic region. Similarly, business is considering sustainability a new market opportunity and a valuable part of brand image. We have recently seen many global companies turning "green" and implementing some sustainable practices in their everyday production and logistics. A successful incorporation of sustainable patterns into any business activity is possible, when its management and staff clearly understand the principles and goals of sustainable development and sustainability. If the understanding and application skills are missing or insufficient there is a high risk of implementing "greenwashing" solution, which can even worsen the situation and increase the ecological footprint of business.

Higher education has taken a mission of developing a "good citizenship" mindset based on sustainability principles. However, sustainable living is just a part of the process, and more ambitious yet challenging is to implement sustainable development goals (SDGs) in everyday professional activity. Thus, students should be taught to find and use opportunities to make the essence of their future work more sustainable. For that, they need skills on how to rethink the existing practices related to their profession and ways of doing business and shape them in accordance to SDGs. However, rethinking is a complex cognitive process, which is currently lacking comprehensive pedagogic techniques and good practices.

Thus, the research question raised in this paper is how to teach students to apply principles of sustainability in their future professional activity and to transform "business as usual" to the one following sustainble pathway?

1. LITERATURE REVIEW

Sustainability and sustainable development are the major paradigms of the modern times aiming to accommodate the needs of population, standards of living and natural reserves of the planet. The essence of sustainable development is evolving and defined through the three pillars (economy, environment and society) (Barbier, 1987), four elements (adding human or culture to the previous system) (Sabatini, 2019) or five domains (Ben-Eli, 2018) and further. The perception of sustainable development depends on the professional background and point of view, but the education calls for clear formulations and business needs well defined action plans and strategies. Therefore, it is often downscaled to principles of sustainability, which could be customized to any field and sector. They are often declared by companies as the goals of development on the whole and a form of social responsibility in particular. The general idea of the principles of sustainability is well formulated by the "Natural Step" framework (Robert, 2000), stating that sustainable society doesn't increase extraction of natural resources, pollution of the environment and degradation of society function ability and safety. Even though, this formulation is a good reflection of what sustainability is, but says not much about how to arrive there. This is the task for educators of the modern era – to train people being sustainable.

ESD is aimed at formation of a new reality of living and doing business, rather than just at giving information and competencies. As such, it deals with issues of multiple social,

economic, political and environmental fields, moving beyond separate academic backgrounds and management competencies to interdisciplinary and transdisciplinary studies (Nordén, 2016; Carrapatoso, 2021; Hilger & Keil, 2022). Since it is impossible for each person to be aware of all these aspects, the key task for ESD is to provide students with understanding of principles and ability of rethinking the existing way of doing things in their industry and business sector. However. rethinking" is a concept usually applied to education as itself since the milestone paper by Bereiter & Scardamalia (1996) and is still considered an important research topic due to acceleration of transitions in social and market demands for skills and competencies (Nasir et al., 2021). Thus, in the given context "rethinking" should be understood as a complex of skills, which enables people to see discrepancy between an existing way of doing things and sustainable pathway in any field from personal professional activity further to a company or a branch of industry on the whole, as well as capacity to develop and implement transformation actions to remove the defined incomplieances and move business and work closer to achieving the SDGs. From such perspective, rethinking is closely connected to critical thinking and gaps analysis, and it aims at development of action competence in the field of sustainability. Action competence is widely interpreted, depending on the field, but basically, it's an individual's ability to choose and perform activities for solving any problems in society (Hedefalk et al., 2014). Currently it is considered a precondition for shifting to sustainable development, and is often seen as the most important result of ESD (Sass et al., 2020).

The newest trends in pedagogy imply shifting from straight delivering information and controlling its memorizing to more dynamic mutual interaction between teacher and student in the "agent – facilitator" mode (Leander & Osborne, 2008; Ogienko, 2016; Lee & Tan, 2018; Cingel Bodinet, 2016). This shift is quite complicated accounting long traditions of "deliver-and-control" method, rooted in the formal official education (Alam, 2013), but it is especially valuable approach for tackling the problem of implementation, faced when it comes to transferring sustainability from theory to real life.

Project-based learning is seen by many researchers and practitioners as the most effective way to bridge theory and practice. Project-based learning embodies the principle "learning by doing", when the students are given an opportunity to develop knowledge and skills through engaging projects set around challenges and problems they may face in the real world (Barron et al., 1998; Krajcik & Bluemenfeld, 2006).

Project based teaching is reported to yield valuable learning outcomes including ability to adapt to changing working environment, as well as react to new market and social demands and challenges in various professional fields, in particular engineering (DeFillippi, 2001; Palmer & Hall, 2011; Halbe et al., 2015; De los Ríos-Carmenado et al. 2016) and entrepreneurship (Okudan & Rzasa, 2006; Hogue & Kapralos, 2011; Cho & Brown, 2013; Huchting et al. 2021). It is also applied as a method in ESD (Lehmann et al., 2008; Halbe, 2015; Duarte et al, 2017; Cörvers et al., 2016), which is said to contribute to developing key competencies in sustainable development, in particular strategic thinking or action-oriented competence (Wiek et al. 2015). The efficiency of this method and other methods of active education is still under investigation and the given research is one of them.

2. METHODS AND MATERIALS

This paper contains the analysis of the efficiency of project-based teaching and learning for the development of rethinking skills within the sustainability framework. The analysis is based on the ESD case studies – university courses involving project design dealing with sustainable development, delivered in higher education institutions of three countries:

- "Sustainable development". Sustainable development planning" and "Sustainable development framework" (Liepaja University, Latvia);
- "Green Chemistry and Engineering" (Lodz University of Technology, Poland);
- "Urban Ecology". European Integration of Environmental Standards for Civil Aviation in the Context of Sustainable Development" and "Environmental Safety of Aviation Activity" (National Aviation University, Ukraine);
- "New Trends in Production" (Wroclaw University of Science and Technology).

The courses were delivered at all three educational degree levels (Bachelor, Master and PhD) with a different number of students involved, ranging from 8 to 200 students per course.

The essence of the project activity was rethinking of any production process and planning actions to change it from the "business as usual" to the one, meeting sustainability principles. Depending on the course, students were working on projects individually, in small groups, or collectively and delivered the results as a written thesis and oral presentation.

The analysis of the given case studies was carried out in two stages. At the first stage, the efficiency of the project-based method for the formation of rethinking skills was measured by the quality of the project solutions, presented by the students. The quality of the projects was evaluated via self-assessment of teachers (course coordinators). The list of evaluation criteria for the teachers' survey included:

- interest to own and other projects done in the class;
- participation in discussions at certain checkpoints of progress and in the final Q&A;
- use of ready solutions;
- originality of ideas;
- depth of sustainable rethinking;
- "greenwashing" signs in the final projects;
- feasibility of project solutions.

The first two criteria show how significant and important sustainability is for students, as well as their action competence towards sustainable development in general.

Students are often prone to using ready solutions, but the project-based method implies the development of creativity, flexibility and search for non-standard solutions, which are collectively of great importance for career and business development. These issues were evaluated with the third and fourth criteria.

The criterion "depth of sustainable rethinking" is a synthetic concept, reflecting the number of a production process's or business's components subjected to transformation and principles of sustainability implemented in projects. In terms of the profession specifics, principles of sustainability implemented should include, but not limited to circular economy, energy savings, sustainable material choices, improved environmental safety of products, reducing inequality, corporate social responsibility, support of

community, carbon footprint reduction etc. A distinctive feature of sustainability is its equal attention to economy, environment and society, which is the ultimate goal of the project activity.

Greenwashing has increased in recent years to meet consumer demand for environmentally-friendly goods and to improve public perception of brands. It describes the situation, when a company claims to be environmentally conscious but actually isn't making any notable sustainability efforts (de Freitas Netto et al., 2020). In many cases these are intentional marketing spins, but students in their projects may be tempted to offer superficial and declarative solutions without realizing that this is not just a simplification of the work done, but also a negative social and economic phenomenon.

Trying to achieve the highest possible sustainability must imply technical feasibility and profitability of project solutions and this is also an important criterion of projects quality.

At the second stage, the project-based courses were analyzed in order to define possible correlations between teaching methods and the quality of the student projects, as well as the rethinking competency they are intended to develop.

The core of the considered courses was application of active learning methods, such as: case studies, design thinking, reflection, and flipped classroom. These methods along with other possible contributing factors were analyzed as possible prerequisites for efficient rethinking and quality of project development, using the standard method of multi-criteria evaluation (Aruldoss et al., 2013). The multi-criteria evaluation (MCE) method has been applied in a range of case studies, dealing with the teaching efficiency assessment (Martínez et al., 2018; Agasisti et al. 2019; Roszkowska & Filipowicz-Chomko, 2020; Popović et al., 2020). For the modeling purposes within the MCE framework the employment of each factor was ranked from 0 to 1, corresponding to not using and full implementation of a factor. The factors were then combined in certain scenarios and multiplied by weighting indices, reflecting factors' relative importance. The weight of the given factors was evaluated by the participating teachers using the method of pairwise comparisons (Lamelas et al., 2012).

3. RESULTS AND DISCUSSION

The self-assessment survey conducted with the teachers, presenting their case studies, shows that they evaluated the quality of student projects from average (50%) to above average (37.5%), with only a small proportion (12.5%) rated as below average, of which all were by the students of Bachelor degree, taking the course at third year. This presumably means that project-based learning yields better results if conducted at the last year of Bachelor training and further with Master and PhD students. The students' interest to project development was high, although it was slightly self-oriented with paying less attention to the projects of classmates. The most important shortcomings of the projects defined by teachers were:

- Students seek for "readymade" solutions and stop their creative engagement for project development at this stage. 62.5 % of student projects contained at least some original ideas, and 25 % were highly original and feasible.
- Most students underestimate SDGs importance for their professional activity and fail to find broad perspectives of sustainability goals' application.

- Most of the projects contained some elements of green washing, though predominantly unintentional, instead of in-depth transformations.

The analysis of the cases studies also yield recommendations for the improvement of the defined shortcomings. Most importantly it was defined that these issues strongly correlate with the level of active learning application in the process of the course delivery. Thus, one case study, completely based on combination of active learning methods and representing the highest number of projects developed, was reported to have minimal display of the issues, related to lacking originality and usage of "readymade" solutions. Thereby we see that active learning facilitate innovative thinking of students and contribute to action competence.

The understanding of SDGs applicability could be reached by adapting them to specific professional field of the students, as it was in case of the course "Green chemistry and Engineering", which is largely based on the corresponding Green chemistry and Engineering principles. The learners of this course demonstrated integral and balanced understanding of SDGs and their possible applications in the professional activity; they were able to see sustainability as a perspective for entrepreneurship and professional development.

Green washing risks exist until their essence and signs are clearly articulated to students, preventing distortion of rethinking process. Being potentially responsible for the decisions made in the field of environment protection and social responsibility in their professional activity and business strategy, students must be provided with this information to make their action competence fair and conscientious.

A set of components, contributing to efficient rethinking practice and high quality project development, was formulated based on the cases studies analysis. These components could be divided in two categories. The first one is about objective factors related to the methods of teaching and learning, as well as course arrangement aspects (Adaptation of SDGs to professional background, Explaining principles of green washing, Case studies, Flipped classroom, Group work, and Common discussion of the progress). The second one is about subjective factors related to general competencies of students and quality of their training (Solid professional background, Research skills, Design thinking, as well as Analytical (Abduction, deduction and induction) skills). The weighting of the contribution of these factors in final learning outcomes demonstrated dominant role of objective factors in the quality of projects and rethinking competency development (see Fig. 1).

To define the best combination of factors, providing high quality of projects and long-term rethinking capacity and action competency, we modeled three scenarios of the project-based course teaching:

- Scenario 1 includes students with well developed general competencies and application of the active methods of teaching to facilitate rethinking process.
- Scenario 2 stands for the case, when students have poor general competencies, but active teaching methods are fully used to facilitate rethinking process.
- Scenario 3 represents traditional "deliver-and-control" method of teaching with well developed general competencies of students.

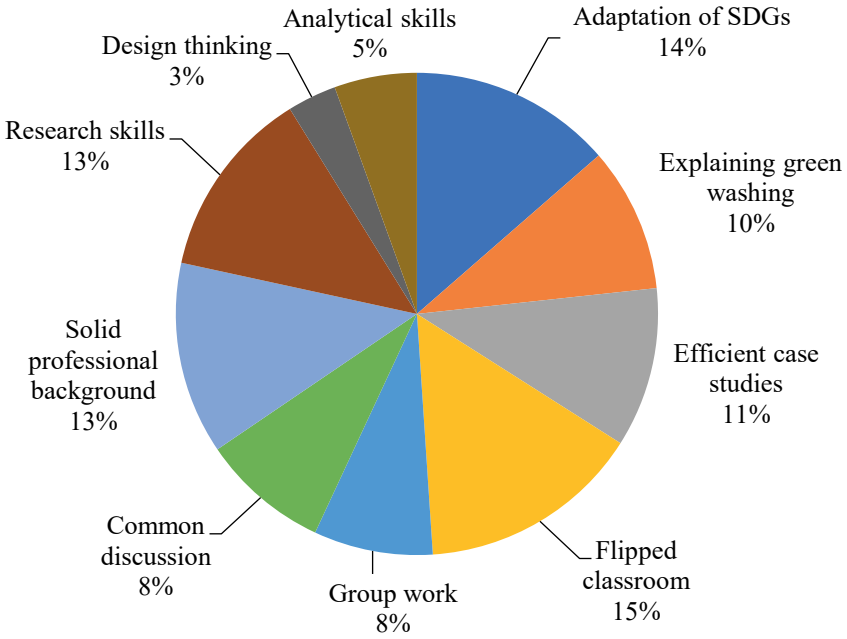

Fig. 1. Weighing of factors, contributing to quality of projects designed and depth of sustainable rethinking.

The results of the modeling (Fig. 2) predictably show that the combination of well-developed general competencies of students and active teaching methods produce the best result. The final score on the diagram is not equal to 100, since there should be a room for evaluation of the project presentation. Still, the most important result of modeling is that combination of active learning methods can give comparably good rethinking results even with the students having poor general competencies, due to promoting their creativity, understanding of SDGs, ideas sharing within the group, and active discussions with the teacher. At the same time, even the best-prepared students fail to demonstrate high quality of rethinking if they were taught in a traditional manner, without application of the above mentioned active learning methods.

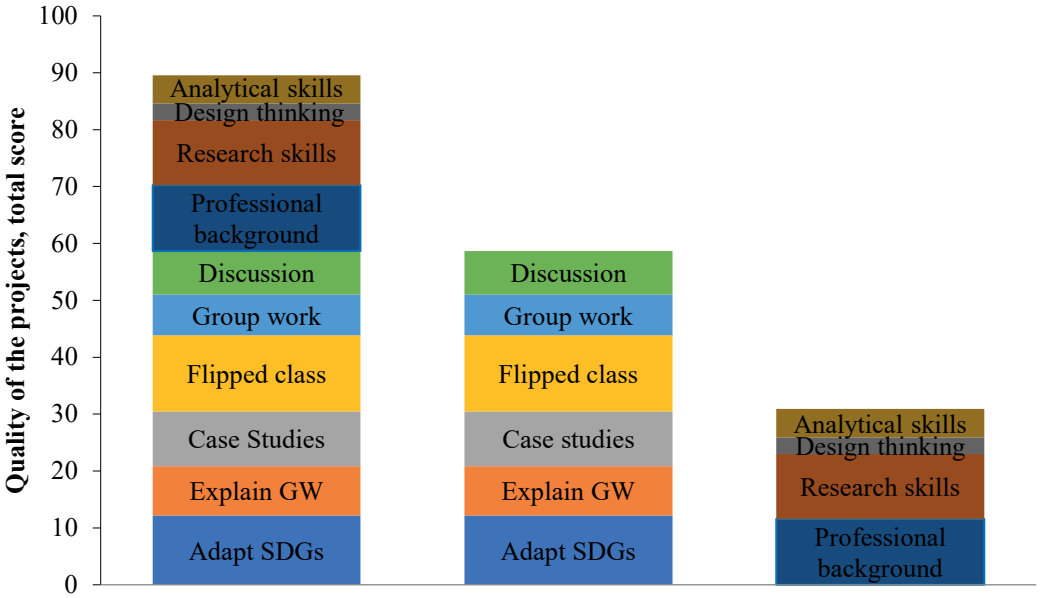

Fig. 2. Comparison of basic scenarios of courses arrangement.

The given research encompasses experience from different degrees, specialties, universities and countries, still having similarities in both negative and positive aspects, which increases the reliability of the obtained results. In spite of the fact that the given case studies do not represent the whole spectrum of peculiarities of the project-based learning for ESD, drawbacks reported in other project design courses argue that it is currently the most reliable bridge to action competence for sustainability and ability to react to sustainability challenges (de Los Rios et al., 2010; Guo et al., 2020). The development of market is forced to move towards sustainability and the existing business and new entrepreneurship incentives are constrained and provided with new opportunities by the sustainability imperative (Lubin, & Esty, 2010). In order to be able to do old and new things in new ways both engineers and business people must be able to rethink their current practices and find strategies to be successful in the sustainable world of the future.

CONCLUSION

Development of rethinking skills and action competence for sustainability is an important element of the modern society proper functioning and economy development in face of multiple environmental and social threats. Acquiring those skills in higher education is possible with the project-based learning, as it was shown on the case studies from Ukraine, Poland, and Latvia. The performed modeling shows the dominant role of active learning methods in teaching to transform production and management practices to sustainable ones, independent from level of general competencies and specialty. It has been described that active learning techniques help preventing students from simple copying of "readymade" solutions, forcing them for co-creation of alternatives to the existing technologies and business strategies.

The following findings could be incorporated in the strategy of project-based learning for rethinking facilitation:

- Localization (adaptation) of SDGs to a professional background could make them less abstract and more applicable for students;
- Active methods of teaching efficiently enhance student project work;
- Group cooperation and collective character of student project work can mitigate lack of some general competencies of some students and contribute to their development in line with rethinking and transformative skills;
- The choice of verified and prominent case studies to demonstrate successful implementation of SDGs in each profession and business sector facilitate the search for alternative solutions and proves their potential feasibility to students;
- A set of criteria to differentiate greenwashing solutions from real transformations for sustainability must be delivered to the students during the course.

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