MULTIDISCIPLINARITY AND INTERDISCIPLINARITY: KEY ELEMENTS FOR TEACHING ENVIRONMENTAL SUSTAINABILITY AT ECONOMIC AND BUSINESS FACULTIES

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Abstract The fact is that topics related to sustainable development are becoming an important integral part of curricula in economics and business higher education. However, the question arises how to include the field into educational practices, what competences and knowledge are required for different study courses (both to lecturers and students) and how to understand interdisciplinarity within different faculty departments. In this paper, we present 30 years of experiences of teaching sustainability topics with the emphasis on environment-related issues given by the members of the Department of technology and entrepreneurial protection at the Faculty of Economics and Business in Maribor. Several decades of experiences confirm that multi- and interdisciplinarity are one of the key features in the education of economics and business students due to the ever-increasing complexity of environmental issues that companies face in practice. In order to demonstrate the importance of multi- and interdisciplinarity in teaching environmental sustainability, we present two cases given in our current courses: carbon footprint calculation and evaluating of "greener" products with the application of software tools and databases (like Life Cycle Assessment tools).

Keywords:
sustainability,
interdisciplinarity,
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1 Introduction

There has been a growing consensus that universities play a strategic role in the promotion of sustainability by creating relevant knowledge and its transfer to the society, and, secondly, by preparing their students for their future roles in the society where they will make sustainable and responsible decisions (Lozano et al., 2015; Figueiro & Raufflet, 2015; Blanco-Portela et al., 2017; Csillag et al., 2022). Several teaching techniques and didactical approaches were proposed on how to integrate sustainable development (SD) into higher education curricula (Figueiro & Raufflet, 2015; Barth & Rieckmann, 2012) and how to overcome barriers of such implementations (Naeem & Neal, 2012; Blanco-Portela et al., 2017; Csillag et al., 2022).

Integrating environmental sustainability topics into economics and business education raises several important questions such as which SD topics should be included into different study courses, how to relate such topics within the already existing courses, what the overall level of the sustainability knowledge of teaching staff is, and where lecturers get their environmental sustainability education and skills to be able to understand very complex environmental impacts interrelations, methodologies and tools.

In such efforts, the staff that lacks sustainability-related skills and has insufficient specialized knowledge of sustainability can be a problem because most academic staff in the past have never received training on the topic and do not feel comfortable to work across disciplinary areas on the topic of sustainability (Csillag et al., 2022). On the other hand, many academics have become "over-night experts", which is even worse. Naeem and Neal (2012) and Peña et al. (2018) reported that the most significant barriers to the integration of sustainability into the business curricula were associated with the lack of training of sustainability themes by most faculty members. Therefore, as emphasized by Lozano (2006), 'educating the educators' is an important element for promoting the incorporation of education for SD into universities, because a clear understanding of SD is necessary for the incorporation of the concept.

It is clear that the complex problems sustainability sciences are facing cannot be addressed sufficiently from a single-disciplinary perspective (Brudermann et al., 2019). Therefore, many authors agree that sustainable development and sustainability implementation require at least multi- and/or interdisciplinary approaches (if not more holistic ones). In such a way, it is possible to overcome too narrow and fragmented teaching in economics- and business-oriented faculties based on the management views only and which cannot embrace the complexity of environmental sustainability that companies face in business practice.

The aim of this paper is to reflect on how environmental sustainability topics as a part of wider SD goals can be addressed in the economics and business curricula by giving the example of the Faculty of Business and Economics at the University of Maribor, where the first courses that integrated environmental pollution and control problems in companies were already launched in 1970s, i.e. long before the importance of such topics was recognized as important in business-oriented schools curricula worldwide. Based on more than thirty years experiences in teaching and researching environmental sustainability issues, we present the importance of multi- and interdisciplinarity approach.

2 The Role of Multi- and Interdisciplinarity in Teaching Environmental Sustainability

Despite significant efforts in last decade and a half, higher education institutions are still far from solving complex SD problems in an interdisciplinary manner as confirmed by several authors partly because they are organized into highly specialized areas of knowledge and traditional disciplines.

Based on literature reports, Watson et al. (2013) observed that many higher education institutions curricula have relied on single-disciplinary specialization and reductionist thinking. As reported by Dlouhá et al. (2017) in a review paper for the case of Central European countries, single disciplinary-based SD courses are introduced without commensurate efforts to create an interdisciplinary or multidisciplinary dialogue. Furthermore, the disciplines may be too often focused on defending their own boundaries and resources (Darian-Smith & McCarty, 2016) what results in fragmented learning (Lambrechts et al., 2013).

Whereas in a single-disciplinary approach, a stand-alone course is taught with no ties to other courses, an interdisciplinary approach means the combination of knowledge of multiple established disciplines for solving specific issues (such as sustainability). In addition, a multidisciplinary approach consists of different fields of knowledge where each discipline retains its own method or theoretical concept and may be responsible for a different topic linked to the sustainability (Figueiro & Raufflet, 2015). Multidisciplinary approaches use the perspectives of a number of different disciplines with no necessary overlap. Interdisciplinary approaches use the methods and theories of one discipline to inform other disciplines (Darian-Smith & McCarty, 2016).

With regard to the study program, the study by Barth et al. (2007) showed that the competence for interdisciplinary cooperation appears to be central and urgently needed for teaching SD topics because personal and specialized knowledge is applied to new questions and problems in different combinations or disciplines and placed in an integrative perspective. However, learning processes which can enable such transformative changes largely depend on academic staff and their capabilities and willingness to support such processes (Barth & Rieckmann, 2012). Unfortunately, the complex structure of educational institutions may involve groups or individuals with diverse interests, which can hinder the process of SD interdisciplinary integration (Figueiro & Raufflet, 2015).

2.1 Environmental sustainability teaching at the Faculty of Economics and Business Maribor

Environmental sustainability and sustainability-related courses have been present in the contents of curricula at the Department of technology and entrepreneurial environment protection since the 1970s. Figure 1 shows the development of environmental and sustainability related contents in the courses given in terms of the share of the number of pages in textbooks written by professors in our department. Also, we develop, transform and upgrade the courses on a continuous basis. Some of the current courses are: Environmental management, Ecology of products, Sustainability of products, Technological and eco-innovation and others. A couple of courses are delivered together with the colleagues from other departments, like Environmental economics and environmental management and Sustainability accounting.

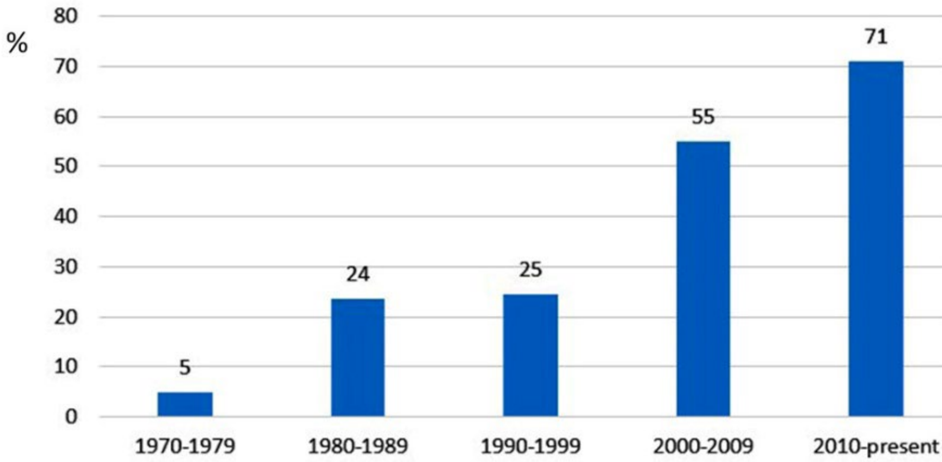

Figure 1: Development of environmental and sustainability related contents in the courses given at the Department of technology and entrepreneurial environment protection
Source: Authors' elaboration.

In the continuation, we present two examples of environmental sustainability topics that are included in the study courses and in the research work of the Department of technology and entrepreneurial environment protection and that are based on the engineering-oriented approach of modelling and calculations of environmental impacts: product carbon footprint (CF) and Life Cycle Assessment (LCA).

3 Case Studies of multidisciplinarity Related to Environmental Sustainability

The case study research methodology was used to demonstrate multi- and interdisciplinarity in the implementation of environmental sustainability topics in economic and business-oriented schools.

The relevant environmental data are the basis for any environmental policy. To determine the impact of processes and products on the environment, they must be calculated accurately. Different methodologies are used for such calculations supported by special software tools and comprehensive databases. Two of such methods are carbon footprint (CF) and Life Cycle Assessment (LCA). Both tools originate from engineering-based calculation procedures and standards and require knowledge on modelling complex product life cycles which is impossible without expert knowledge of technological processes, energy and mass flows, raw materials, materials, energy conversions, etc.

If companies want to implement a greenhouse gases (GHG) reduction strategy and if they want to declare their products as more environmentally friendly, the results obtained from CF and LCA calculations are crucial. Data obtained by CF and LCA calculations are nowadays widely used in research and development, environmental management, marketing and supply chain management etc. However, management and marketing decisions and claims cannot take place without data obtained by such methods. Moreover, the interpretation and contextualization of such data cannot be successful without knowing the background of data determination.

To understand environmental impacts of a company or a product, the understanding of various environmental categories is necessary, which is based on natural sciences. Secondly, both methods, although widely used, have several methodological shortcomings that needs to be taken into account when interpreting the results and setting the decision-making priorities (Radonjič, 2015). In addition, if one really wants to understand the CF concept, the concept needs to be placed in the wider context of environmental sustainability, which means comparing it with other environmental impacts and methods.

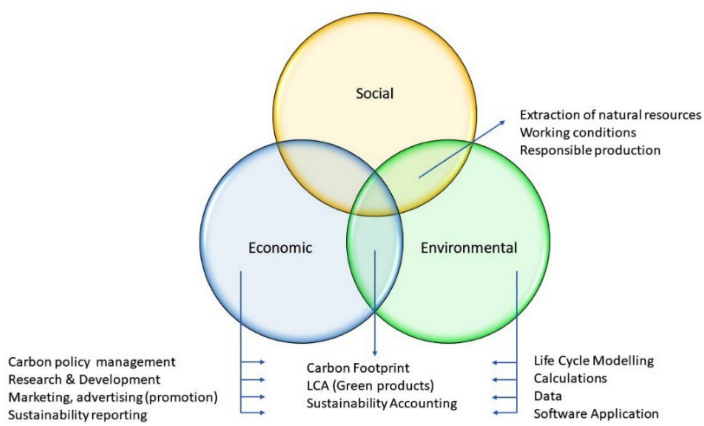

Figure 2: Connections between environmental engineering and business/management topics within the SD framework

Source: Authors' elaboration.

Due to these reasons, CF and LCA are good examples for studying multi- and interdisciplinarity in business practice, as they combine both engineering and management approaches of environmental sustainability. Figure 2 shows some examples of interdisciplinary interwining of these fields within the SD framework.

3.1 Carbon footprint calculation procedure

Although widely used in business decisions nowadays, CF is an environmental parameter based on a special engineering- oriented calculation procedure defined by standardized methodology to quantify GHG emissions. There are two main CF types: the product CF and the organizational CF. After CF determination, the obtained data can be used to establish carbon policy in companies, including goal setting for GHG reduction, for sustainable reporting and for the detecting the most contributing sources of GHG emissions along supply chains. CF can be calculated by different calculation methods, resulting in different final values; therefore, calculations require expert knowledge. This also includes the knowledge on energy sources, their calorific values, heat and energy consumption, special conversion factors for single energy sources and selection criteria on global warming potentials.

Several GHGs exist with completely different emission sources. In case of CO_2 related emissions, the energy consumption data are collected and converted to CO_2 emissions by multiplying it with special emission factors (equation 1). In order to do this, selection of relevant emission factors must follow energy conversion characteristics of different fossil fuels and related energy technologies, CF standards guidelines and/or data from national energy operators.

$$\text{GHG emissions} = \Sigma\, (AD_i \times EF_i) \tag{1}$$

where AD_i represent activity data from source i (based on a unit of measurement), and EF_i is emission factor for source i (kg CO_2/unit of measurement). When dealing with the quantities of fuels, expressed in tonnes and/or m^3, net calorific values has to be used to calculate the amount of energy per tonne or m^3.

To calculate a CF, emission quantities of individual GHGs have to be converted to so-called carbon dioxide equivalents (CO_2eq) using Global Warming Potentials (GWP_i) values (equation 2). That allows different GHGs to be compared on a basis relative to one unit of CO_2. Measuring the comparative impact of different GHG is further complicated by the fact that different GHGs vary both in the greenhouse effect intensity in atmosphere and how long they remain in atmosphere. Therefore, GWP_i factors must be carefully selected, since they are available for different time horizons (20 years, 100 years and 500 years).

$$CF\ (CO_2eq) = \Sigma\ ((GHG\ emissions)_i \times GWP_i) \quad (2)$$

In addition, biogenic carbon uptake (CO_2 removed from the atmosphere) has to be included as well. Finaly, the CF result represents a sum of particular GHG emissions (expressed as CO_2eq), reduced for biogenic carbon uptake (equation 3).

$$CF\ (CO_2eq) = \Sigma\ ((GHG\ emissions)_i \times GWP_i) - CO_2eq\ biogenic \quad (3)$$

For product CF calculation, life cycle of product must be modelled first on a basis of engineering principles of mass and energy flows, backed by the application of special software tools. However, calculating CF has a limited practical value if we do not have an indication of which processes contribute most to such a result. This kind of indication can easily be given by special software tools, linked to verified environmental databases.

3.2 Using LCA methodology in defining 'green' products

LCA is a complex analytical method that determines the impacts of products throughout their life cycles, covering the extraction of raw materials and energy resources, the production of materials, chemicals and energy, the production of intermediate products, products and by-products, transport and distribution, impacts during use and after disposal. The LCA method quantifies mass and energy flows and links them to different environmental and health impacts. It can include up to 22 environmental categories, including carbon footprint. The results of an LCA help to identify how different products differ in terms of their environmental impacts, which are the most impactful stages in the product life cycle, which environmental impacts are most problematic and how a change in one part of the life cycle affects the other phases. Thus, LCA is known for its intensive contribution to better decision making which qualifies it as one of the most distinguished tools for products eco-design of products and strategic decision-making regarding products development and marketing. LCA results represent the information basis for decisions whether a certain product is more environmentally friendly or not. Without LCA calculations such decisions are not relevant and can lead to greenwashing when comparing products.

As an example of LCA analysis, we show the application of LCA using the SimaPro software for double-layer laminated packaging produced from low-density polyethylene and polyamide used in the food industry for vacuum or modified atmosphere packaging. Methodological and data details of the study can be found in (Denac & Radonjič, 2019). The SimaPro software tool, supported by comprehensive environmental databases was used which enables the results to be presented in a wide range of graphics and formats (Figure 3). From Figure 3, we can detect which packaging's life cycle phases contribute the most serious environmental impacts.

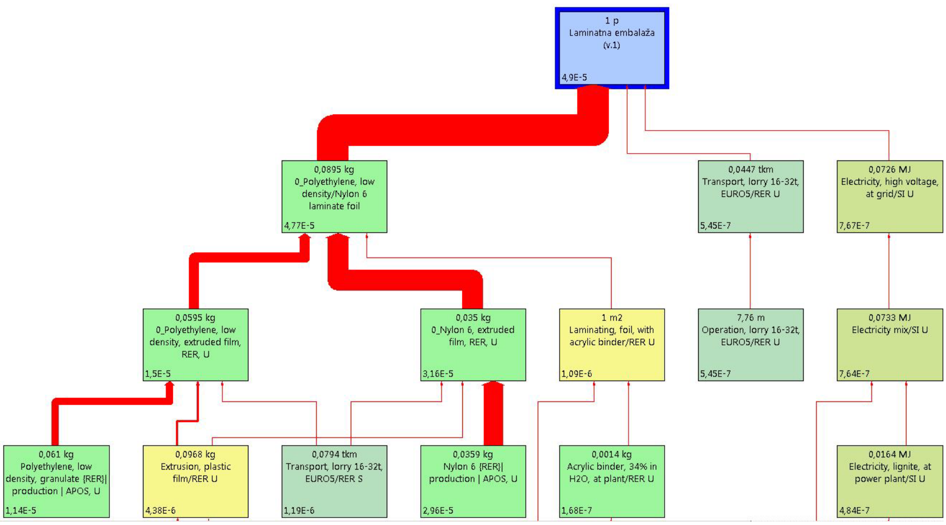

Figure 3: LCA graphical presentation of the environmental impacts calculated by SimaPro software of the laminate packaging (based on ReCiPe calculation method)
Source: Authors' elaboration.

4 Discussion and Conclusions

This paper reflects the need to move beyond the single-discipline/interdisciplinary divide. It raises the awareness that multi- and interdisciplinary approaches to sustainability teaching within and among different courses at the economics and business higher education institutions is required in order to achieve a correct understanding of environmental problems in business practices. Namely, very often environmental topics related to business practices require an understanding of natural sciences phenomena or engineering-oriented calculations to deal with proper contextualization and implementation. In order to obtain necessary quantitative data on which a company's effective environmental policy is based, calculation procedures and modelling of complex products life cycles are required based on engineering principles.

One of the reasons why there are so many examples of greenwashing in business practice is the insufficient knowledge of marketing and management staff about determining the overall life cycle effects of products on the natural environment and human health. Engineering-like modelling and use of modern tools and software are necessary to support marketing and management decisions with relevant data.

However, it has to be emphasized that even interdisciplinarity in the sense of combining knowledge from different academic disciplines is still insufficient for tackling complex real-world problems. More holistic approach is necessary to attain the transition to a more sustainable economy serving all three SD pillars: environmental, social and economic. Although this paper is limited on environmental dimension of SD, multi- and interdisciplinarity approach is essential for social/environmental and social/economic interactions, too.

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