

# SUSTAINABILITY EDUCATION IN THE FIELD OF INDUSTRIAL ENGINEERING AND MANAGEMENT: THEORETICAL CONCEPTS AND PRACTICAL APPLICATIONS

Volker Koch<sup>1</sup> [0000-0001-9278-2211], Marco Berger<sup>1</sup> [0000-0002-6955-1674],  
Amila Omazic<sup>1</sup> [0000-0002-6602-5978], Bernd Markus Zunk<sup>1</sup> [0000-0003-0985-4769]

<sup>1</sup> Graz University of Technology, Faculty of Mechanical Engineering and Economic Sciences,  
Institute of Business Economics and Industrial Sociology, Austria

**Abstract:** *Sustainability has become an increasingly critical consideration in the field of industrial engineers and management (IEM) professionals. As companies face growing pressure to balance profitability with environmental and social responsibility, the need for higher education institutions (HEIs) to incorporate sustainability principles into their curriculums has become evident. Teaching sustainability in business economics provides students with a comprehensive understanding of the environmental and social impacts of business activities. By emphasizing the interconnectedness between business decisions and sustainable outcomes, students gain a broader perspective on the long-term consequences of their actions. They become equipped with the knowledge and tools to make informed choices that promote environmental control, social equity, and economic prosperity. One of the main challenges in teaching sustainability lies in bridging the gap between theoretical concepts and practical application. To address this, educators can adopt experiential learning methods such as case studies, simulations, and real-world projects. These approaches enable students to analyze real-life business scenarios and devise sustainable strategies. By engaging in hands-on activities, students develop critical thinking skills, problem-solving abilities, and a deep appreciation for the complexities of sustainable business practices. Results will focus on following key approaches of teaching sustainability in the field of IEM: sustainable business models und sustainable finance*

**Keywords:** *Industrial Engineering and Management, Engineering Education, Competence Profile, Sustainability, Teaching Concepts*

## 1. INTRODUCTION

In the past decade, sustainability has emerged as a central theme at higher education institutions (HEIs), accompanied by the belief that education could play a pivotal role in driving sustainable development (SD) strategies. As a result, the United Nations' decade of education for SD emphasized the integration of sustainable development theory and practices into educational frameworks. These initiatives have sparked a transformative shift in the education landscape, giving rise to the paradigm of education for SD (Stein, 2019; Yli-Panula et al., 2020; Buckler & Creech, 2014).

Most importantly, education for SD empowers students to gain direct experiences with sustainability through innovative learning approaches. By engaging with this framework, students can directly witness the impact of sustainable practices, fostering a deeper understanding of the importance of sustainability in their lives and broader society. Through education for SD, HEIs play a crucial role in nurturing environmentally conscious and socially responsible individuals who are equipped to address the pressing challenges of our time (Kishita et al., 2018; Bedawy, 2014).

Furthermore, there has been a notable surge in government policies, academic initiatives, corporate engagement, and public interest aimed at advancing the journey towards sustainability. This growing momentum underscores the collective recognition of the urgent need to preserve the environment, utilize resources prudently, and create value for society, all while ensuring long-term economic competitiveness. These focal points encapsulate the essence of sustainability as a well-defined concept, addressing the multifaceted challenges of our times (Lynch, 2019; Behnam et al., 2018).

Recognizing the urgency, it becomes crucial to comprehend the driving forces behind this necessary transformation. The transformation towards sustainability within higher education requires a

multifaceted approach. A willingness to embrace sustainability among programme directors, coupled with supportive regulations, standards, and faculty commitment, will collectively drive change within HEIs. (Barth, 2015; Weiss & Barth, 2019).

Previous research highlighted the lack of integration of SD aspects into higher level operations management (OM) education (Fredriksson & Persson, 2011). Furthermore, OM is recognised as one of the fundamental fields in engineering education, especially for supporting SD, since it combines design, operation, improvement and transformation of input resources into output products and services (Fredriksson & Persson, 2011). Recently, a lack of studies focusing on the OM and SD integration in engineering education has been identified, especially in the context of didactic practices (Rampasso et al., 2019). It is necessary that SD fundamentals are integrated into engineering field, especially into engineering education (Frederiksson & Persson, 2011). For this reason, certain improvements in engineering education are needed, to motivate students to rethink their future professional roles and to recognise the necessity for creating value for all stakeholders, while providing a safe, healthy and quality workplace (Frederiksson & Persson, 2011). Necessary improvements in engineering education call for a variety of complex and transdisciplinary adaptations based on evidence-based competence profiles to contribute to the safety, health, and welfare of the public (Rampasso et al., 2020; European Commission, 2019). Integrating sustainability into the curriculum of IEM at HEIs is crucial in preparing future professionals to address the challenges of global environmental and social issues.

Based on the above statements this paper aims to narrow the scope and answer the following research question: What are theoretical concepts and practical implications to teach sustainability in the context of business economics at higher education institutions?

## 2. METHOD

According to Omazic et al. (2022), to tackle the complexities posed by contemporary challenges of sustainability education in the field of industrial engineering and management a pioneering initiative known as a "Sustainability Business Economics Lab" (SBEL) was implemented. The primary objective of this innovative lab is to cultivate sustainability competences among students specializing in the field of IEM. By integrating sustainability skills with their technical and economic expertise, the lab empowers students to approach problems in the area of techno-economics with a critical, analytical, and sustainable mindset. The SBEL is designed as a competence-based platform that goes beyond traditional classroom learning. It provides IEM students with hands-on experiences and practical scenarios to apply sustainability principles to real-world industrial challenges. By engaging in this dynamic learning environment, students gain the skills and knowledge needed to make informed and sustainable decisions in their future professional endeavors (Omazic et al., 2022).

Through the SBEL, students learn to analyze the socio-economic and environmental dimensions of complex industrial issues. They are encouraged to think holistically, considering the long-term impacts of their decisions on various stakeholders and the environment. By incorporating sustainability into their problem-solving approaches, students develop a heightened awareness of the interconnectedness between economic growth, technological advancement, and environmental stewardship. Furthermore, the lab fosters interdisciplinary collaboration, allowing students to work in teams with diverse backgrounds, sharing their expertise and insights to tackle multifaceted challenges. This collaborative spirit prepares students to thrive in a globalized world, where sustainability challenges often require a collective effort from professionals with different skill sets and perspectives (Omazic et al., 2022).

IEM students emerge as future change-makers and leaders, ready to shape industries in a way that aligns with sustainable development goals and brings about positive transformation in society. In conclusion, the SBEL represents a pioneering educational approach that synergizes sustainability competence with technical and economic skills, empowering IEM students to approach challenges critically, analytically, and sustainably. This transformative learning experience equips students with the tools they need to contribute meaningfully to the advancement of techno-economics while maintaining a steadfast commitment to environmental and social sustainability. As depicted in figure 1, the modules (phases) of the SBEL have been carefully crafted, drawing inspiration from the three commonly employed models of

collaborative learning in engineering courses: classroom-based, laboratory-based, and project-based modules (Schnak, 1996; Rodriguez-Sanchez, 2020).

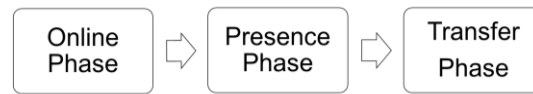


Figure 1: SBEL Methodology (Omazic et al., 2022)

The three phases of the SBEL of Omazic et al., 2022 are summarized and briefly described below.

The primary objective of the online phase is to equip students with a comprehensive understanding of sustainability within the context of business economics. This phase commences with a kick-off meeting, where the instructor outlines the learning and teaching concept, sets the goals, explains the assessment methods, establishes the sequence of events, and introduces useful tools to enhance the learning experience. As a crucial step in gauging students' current level of sustainability competence, a survey is conducted during the online phase. This survey draws upon the wealth of knowledge present in scientific literature concerning the cultivation of sustainability competence in education. Through this assessment, the online phase aims to gauge students' proficiency in specific sub-competencies related to sustainability (Omazic et al., 2022).

During the presence phase, students take on the roles of experts as they deliver their presentations on the generic introduction to sustainability in the context of business economics. This interactive phase allows for in-depth discussions and knowledge-sharing among peers, fostering a deeper understanding of sustainability concepts. Students are organized into small and homogeneous teams to collaboratively work on case studies provided by the instructor. This team-based approach encourages effective communication and collaborative problem-solving. (Omazic et al., 2022).

In the transfer phase, students review and update their initial survey on sustainability competence. They provide comments on changes and improvements experienced during the SBEL. This feedback helps observe individual learning pathways and refine the course content and teaching methods. An anonymous feedback session on the last day further ensures continuous quality assurance (Omazic et al., 2022).

The methodological approach of this paper is centered on competence-based education and training. It follows a modularized program architecture and utilizes digital teaching and learning formats within the area of sustainable business economics. Therefore, literature based theoretical concepts and practical implications will be introduced with focus on the presence phase for the SBEL. For this purpose, different topics in the areas of sustainable education were evaluated in scientific publications. Care was taken to ensure that the subject areas can be used for the presence phase. The search query was performed in google scholar.

### 3. RESULTS

The results show a various sustainable practices and strategies in the design and optimization for sustainable education. In this context, the results will focus on following key approaches of teaching sustainability in the field of industrial engineering and management: sustainable business models und sustainable finance.

#### 3.1 Sustainable business models

Teaching sustainable business models involves educating students about innovative and responsible approaches to conducting business that prioritize environmental, social, and economic sustainability. This type of education aims to equip future IEMs with the knowledge and skills needed to lead organizations towards a more sustainable future (Williamsson et al., 2022; Stadlaender et al., 2021).

The first step is to provide students with a comprehensive understanding of sustainability principles and their significance in the business context. This includes exploring concepts like the triple bottom line, circular economy, social impact, and stakeholder engagement. A next step is Integrating real-world case studies and best practices to demonstrate the successful implementation of sustainable business models. By analyzing companies that have effectively integrated sustainability into their strategies, students can gain insights into practical applications and potential challenges. Teaching sustainable business models often involves adopting a systems thinking approach. Students learn to view businesses as part of a larger interconnected system, understanding the broader impacts of their decisions and actions on society and the environment (Karlusch et al., 2018; Williamsson et al., 2022; Stadtlaender et al., 2021; Geissdoerfer et al., 2018).

Encouraging collaborative learning fosters peer-to-peer discussions, idea sharing, and problem-solving. Group projects and activities allow students to work together to develop innovative and sustainable business solutions. Practical workshops and simulations allow students to engage in hands-on activities, such as designing sustainable business plans, conducting environmental impact assessments, or analyzing sustainability reports. Teaching sustainable business models also involves exploring ethical considerations and responsible decision-making. Students learn to navigate complex ethical dilemmas and make choices that align with sustainability values. Encouraging students to explore and develop sustainable innovation ideas nurtures creativity and entrepreneurship thinking. This involves thinking outside the box to create products, services, and business models that contribute positively to society and the environment. As sustainability practices evolve, it is essential to emphasize the importance of continuous learning and adaptation. Teaching students to stay informed about the latest sustainability trends and practices ensures they remain effective and relevant in their careers. (Omazic et al., 2022; Stadtlaender et al., 2021; Geissdoerfer et al., 2018; Janker & Faber, 2019).

By incorporating these approaches, educators can effectively teach sustainable business models, inspiring the next generation of business leaders to prioritize sustainability and contribute to a more sustainable and resilient global economy.

### **3.2 Sustainable finance**

Teaching sustainable finance in the context of business administration for IEM focuses on integrating environmental, social, and governance (ESG) factors into financial decision-making. Students can explore concepts like impact investing, green bonds, and socially responsible investing (SRI). They can learn how financial institutions can use their influence to direct capital towards sustainable projects and environmentally friendly initiatives. Following key aspects and approaches to teach sustainable finance should be considered (Poyser & Daugaard, 2023; Annand, 2015).

Educators introduce students to the concept of ESG integration, which involves assessing companies' environmental, social, and governance performance alongside financial data. Students learn to identify ESG risks and opportunities and understand how these factors can impact a company's financial performance and long-term sustainability. A next step is Impact investing. This is an essential aspect of sustainable finance, where investments are made in companies or projects that aim to generate positive social or environmental impacts while also achieving financial returns. Students explore different impact investing strategies and evaluate real-world impact investment opportunities (Belinga & Morsing, 2020; Ziolo, 2020).

Furthermore, sustainable finance involves exploring investment vehicles such as green bonds and sustainable funds. Students learn how green bonds raise funds for environmental projects, and how sustainable funds invest in companies with strong ESG performance. Teaching responsible investment strategies involves understanding various approaches like negative screening (excluding certain industries), positive screening (including sustainable industries), and best-in-class selection (investing in companies with leading sustainability practices) (Oulton, 2019; Annand, 2015).

Sustainable finance considers not only financial risks but also non-financial risks related to ESG factors. Students should learn how to incorporate sustainability risks into risk management practices and investment decision-making. A following aspect is corporate sustainability reporting. Understanding

corporate sustainability reporting and the disclosure of ESG-related information is crucial for sustainable finance. Students analyze sustainability reports to evaluate a company's commitment to sustainability and its potential impact on investment decisions. Furthermore, sustainable finance involves engaging with various stakeholders, including investors, companies, regulators, and NGOs. Students explore the importance of stakeholder engagement in promoting sustainable finance practices and influencing corporate behavior. Sustainable finance also encompasses ethical considerations (Poyser & Daugaard, 2023; Annand, 2015; Oulton, 2019).

By offering a comprehensive curriculum that covers these aspects, educators can equip students with the knowledge and skills needed to navigate the evolving landscape of sustainable finance and contribute to building a more sustainable and socially responsible financial system.

#### 4. CONCLUSIONS

This paper emphasizes the critical need for an educational offensive on sustainable development, given the growing legal regulations and resource demands that impact prosperity and peace. The Sustainable Business Economics Lab of Omazic et al., 2022 presented a showcase of an innovative teaching method and a modular program structure, offering a blueprint for future IEM education. Teaching sustainable business models involves instilling innovative and responsible practices prioritizing environmental, social, and economic sustainability. Equipping future IEMs with such knowledge and skills is essential for leading organizations towards a more sustainable future. Similarly, teaching sustainable finance in business administration for IEMs integrates ESG factors into financial decision-making, exploring impact investing and environmentally friendly initiatives. This ensures students comprehend how finance can direct capital towards sustainable projects. Both approaches sustainable business models and sustainable finance contribute to fostering environmentally conscious and socially responsible professionals.

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