

# Fostering Skills for Sustainability – Lessons Learnt from Curriculum Design and Learning Outcomes

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## Abstract

Sustainability thinking plays a key role in business development and transformative approach for a safe, sustainable and prosperous future. Education is expected to take action to provide meaningful learning opportunities in different settings and contexts to foster critical thinking thereby understanding the importance of sustainable lifestyles, a climate-neutral economy and a fair society.

Given the increased responsibility of higher education providers for preparing students as future responsible change agents, the study analyzed the curriculum design to foster sustainability skills of students in the particular case of the educational project for cooperation in higher education, implemented from 2020 to 2022. A quantitative survey was conducted aiming at assessing the learners' satisfaction and the fulfillment of learning outcomes, drawing up findings and improvement gaps to facilitate further exploitation of results.

The findings suggested the improvements from one session to another and the positive changes induced through the aid of course objectives, specific learning outcomes, and the correlation between sustainability themes, SDGs topics, and subjects taught. These stimulated the acquisition of knowledge, skills and attitudes toward sustainability as well as hands-on opportunities to change the status quo, to improve teaching and learning, enabling a better alignment of curricula outcomes in the area of business engineering education.

Finally, the authors highlighted the curriculum content and methodological approach may be used and adjusted in different educational settings boosting synergies with other initiatives of a similar nature in other institutional and national contexts.

*Keywords: sustainable development, curriculum design, learning outcomes, sustainability skills, quality education*

## 1. Introduction

Sustainability thinking plays a key role in business development and transformative approach for a safe, sustainable and prosperous future. Businesses have a central role in delivering the products and service that society need (e.g. transportation, connectivity, health and wellbeing, food, water and sanitation, etc.) and they can contribute to the transformative change through their own actions and collaboration with stakeholders including customers, suppliers, start-ups and industries. They need to be aware of the direct connection between sustainable development challenges and long-term value generation and are called to focus on building skills and enhancing collaboration with the education sector (WBCSD, 2021).

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As with other sectors, education is expected to take action to provide meaningful learning opportunities in different settings and contexts related to green transition and sustainability to raise awareness of the benefits and opportunities of learning for sustainability and develop comprehensive curricula frameworks more relevant to learners. By local examples including climate change, biodiversity and sustainability issues and active collaboration with businesses for hands-on opportunities to observe and care for nature, save resources, repair, reuse and recycle, the learners are supported to foster critical thinking thereby understanding the importance of sustainability lifestyles, a climate-neutral economy and a just society (European Commission COM (2022) 11 final).

In this view, the New European Skills Agenda for sustainable competitiveness, social fairness and resilience acknowledged the critical role of skills for long-term and sustainable growth, productivity and innovation and therefore a key factor for the competitiveness of businesses of all sizes. This goes beyond technical skills but also includes the increasing need of the labour market for transversal skills like cooperation, creative solving and critical thinking which enable students to discern information from various sources, identify misleading information, make informed decisions, be resilient and act responsibly (European Commission COM (2020) 274 final).

Given the increased responsibility of higher education providers for preparing students as future responsible change agents, the study analyzed the curriculum design and learning outcomes to foster sustainability skills of students in the particular case of the educational project for cooperation in higher education, implemented from 2020 to 2022. To this end, the methodological flow consisted of secondary research on the topical scientific literature on the critical role of effective curriculum design to foster sustainable outcomes. Secondly, the feedback survey was undertaken to evaluate the degree of learners' satisfaction and to assess the fulfillment of planned learning outcomes, drawing up findings and improvement gaps to facilitate further exploitation of results.

## **2. Theoretical background**

The concern for continuing development of higher education to help students develop domain-specific knowledge and metacognitive skills brought attention to scholars who proposed a sustainable approach to teaching and learning. According to Geitz and de Geus (2019) the education for sustainability has to focus on learning, equipping students with learning strategies or the skills of learning how to learn instead of excessive emphasis on the outcomes in terms of grades. They advocated for multiple layers of a sustainable learning environment which bring together the theoretical insights of self-regulated learning (e.g. capacity to set task-related and reasonable goals, take responsibility for learning, and maintain motivation) and design-based education phases in terms of researching the question, defining the core problem, generating ideas, designing and testing prototypes, and improving. Notably, practical implications guiding teachers were highlighted to approach the transition to education environments more conducive to sustainable teaching and learning.

Current researchers devoted their attention to analyzing the ways of integrating sustainable development into the engineering curricula either through specific subjects relevant to sustainability issues in engineering or through integrative techniques that incorporate

sustainable development into the entire curriculum. The results pinpointed the limited presence of courses fully dedicated to sustainable development which are in most cases electives being mainly developed for the second or the fourth year of bachelor's studies. The recommendations advocated for the need to facilitate interdisciplinary knowledge of sustainable development concepts within the regular courses which may increase opportunities for engineering students to incorporate sustainability principles into their professional life (Nikolić & Vukić, 2021).

A narrow approach to engineering education addressed the role of sustainability topics in engineering professions, proposing a curriculum built upon innovations in technologies to cover sustainability along with environmental and social implications. Particular emphasis was put on sustainable design covering energy efficiency and convenience in the built environment to meet all sustainability pillars concerning economic growth, social development, and environmental protection. The findings provided guidelines for curriculum design, criteria for evaluating teaching courses as well as methodological aspects related to increasing the involvement of students in the learning process (e.g. collaboration, tutorial sessions, working in teams, inviting external subject matter experts, etc.) which may produce great potential in steering engineers in the direction of sustainable design (Elsaadany & Helmi, 2018).

An interesting attempt has rethought the curriculum by implementing sustainability indicators in engineering education to fulfill the requirements of society related to sustainability. In particular, the authors devised a methodology to integrate relevant sustainability indicators and sustainable development goals (SDGs) in the design and strategic endeavor of higher education institutions. The findings pinpointed the responsible factors for addressing the sustainability requirements such as commitment to continuous improvement and quality assurance, international cooperation, industrial partnership, and engagement with alumni as well as philanthropy and volunteerism, community engagement, and developing economically autonomous universities. Although engineering education seemed to unequally address the sustainability requirement with a strong focus on the sociocultural dimensions and less emphasis on environmental and economic aspects, the results stressed that addressing the majority of the seventeen SDGs may be possible through a well-designed engineering education system (Al-Bahi et al., 2021).

Given the connection between research and education, the quest for curriculum and related competence framework has drawn attention to scholars to design curricula and pedagogies to help students to become more responsible factors addressing future sustainability challenges. Anticipation, reflexivity, inclusiveness and responsiveness were key competencies to be embedded in the curricula to embrace the complexity of responsible research and innovation. The findings acknowledged that even if the curriculum structure based on different specializations remains essential, providing gateways in the curriculum for interdisciplinary inquiry can enable students to work towards cross-fertilization of disciplinary and also practical knowledge to address complex interconnected challenges. Also, improvement recommendations were provided for higher education actors which put more emphasis on rankings, productivity, income generation, and knowledge commercialization instead of implementing appropriate measures (e.g. incentives in academic staff recruitment and promotion criteria to support the embedding

of responsible research and innovation in curricula) to redesign curricula to foster new and more responsible forms of teaching and learning (Tassone et al., 2018).

The critical roles of teachers in designing curriculum for sustainability outcomes were also analyzed and the findings advocated for suitable pedagogical measures to be adopted in the pursuit of improving teaching and learning practices such as developing the personality of the learners and their competencies through better knowing the individual characteristics, creating a participative learning environment as well as mastering the content of the subjects taught (Gadušová et al., 2019). Additionally, it was found that teachers lacked needs and values and that there were no value-methodological principles for incorporating environmental and humanistic values into curriculum design, but that developing teachers' value-cognitive traits was seen as an adequate solution for the new model of education that places people as the primary focus of sustainable development. (Galtseva et al., 2020).

In order to support active learning in the particular condition of engineering education—which is necessary to deal with the contemporary context of high use of rapidly changing technological demand in the globalized world—appropriate teacher abilities were identified as being necessary. The most valued teaching-learning approaches for sustainable engineering education have included teamwork, teacher-student relationships, using new technologies and offering feedback throughout the learning process. Additionally, the development of strategies and methodologies for teaching purpose that concomitantly seek to consolidate students' learning should consider the effects of teachers' intrinsic motivation, innovation, creativity, mental and psychological control, and working conditions that add quality to engineering education (Neves, Lima & Mesquita, 2021). Other scholars argued the teaching value of sustainability, teaching approach and evaluation, curriculum mapping, and the responsible management of teaching development as effective high-quality teaching in the pursuit of adding the value of education for sustainable development (Lai & Peng, 2019).

To further advance education for sustainable development, Sánchez-Carracedo et al. (2021) designed tools to enable the diagnosis of the extent to which sustainability competencies are integrated into higher education. Having a broader scope, the proposed engineering sustainability map encapsulated several learning outcomes defined in correlation with UNESCO key competencies (e.g. critical thinking, system thinking, anticipatory, normative, strategic, collaboration, integrated problem solving, and self-awareness) which were tested in the particular case of engineering curricula. The findings mentioned the substantial role of four competencies units (e.g. application of ethical values, engagement in community processes, sustainable resource usage, and critical contextualization of knowledge) to guarantee the acquisition of sustainability competencies. Other attempts on the institutional level developed qualitative and quantitative tools enabling higher education actors as well as teachers to assess courses and sustainability learning outcomes. The findings figured out that the higher the degree of maturity in curriculum design at the institutional level, the better the learning outcomes for sustainability-related competencies. Although there is a strong emphasis on the need to improve the effectiveness and quality of teaching to foster sustainability commitment, there is still a shortage of comprehensive methodologies to assess the improvements in the performance of higher education institutions (Venezia & Pizzutilo, 2022).

Given the complexity of sustainability subject in the case of education (i.e. economic, environmental and social dimensions), with multiple connections to a wide variety of stakeholders (e.g. higher education institutions, teachers, students, local community, etc.) and different education contexts, the challenges of understanding and adopting good practices for curriculum design with embedded sustainability learning outcomes are still in place. Therefore, locally-rooted inquiries into a particular educational context (e.g. business engineering education) may provide useful lessons learnt to guide the progress in the pursuit of curriculum improvement toward teaching and learning for sustainability outcomes.

### 3. Research Methodology

The survey was designed to evaluate learners' satisfactions and the fulfillment of planned learning outcomes focused on sustainability-related knowledge and skills. The sample size consisted of 45 students in the business engineering specialization at a technical university in Romania who were involved in the course aimed at the development of citizenships and sustainable business. The geographical spread of the sample is linked to Bucharest city (i.e. the capital of Romania country) being constituted by students enrolled on volunteer basis due to the elective format of the course.

The unit of analysis consisted of the course framed by sustainable development concerns and developed throughout the project, rolled out and tested through two e-learning sessions (i.e. session 1/2021 for testing and session 2/2022 for adjusting). Each session entailed a volume of work of 30 hours split among 10 hours for teaching and 20 hours for practical learning activities. The communication with learners relied on synchronous communication with students via MS Teams digital platform and asynchronous communication via Moodle educational platform.

In this view, table 1 shows the planned objectives of the course aimed to support the adoption of sustainable business concepts and models, and responsible citizenship into relevant education curricula by better exploiting of transformational benefits of ITC-based teaching and learning.

**Table 1.** The framework with learning objectives of the course

General objective	Specific objectives
<b>To increase awareness of SDGs at the level of students beneficiaries</b>	1. To become acquainted with key drivers of sustainability concerns (economic, social, and environmental topics)
	2. To acquire useful knowledge for solving sustainability issues and developing sustainable businesses
	3. To understand, integrate and apply the knowledge of citizenship and sustainable business development in different working contexts

The EntreComp Framework provided a common conceptual approach with knowledge, skills and attitudes to foster entrepreneurial learning as a transversal competence useful to all spheres of life from fostering personal development, to actively participating in society

as an employee or as a self-employed person (Bacigalupo et al., 2016). Understanding the complexity of the ability to turn ideas into actions that generate value for someone other than oneself (i.e. entrepreneurship) is supported by a set of three intertwined competency areas (e.g. ideas and opportunity, resources, into action), 15 building blocks of interrelated competencies and a set of learning outcomes linked to different levels of proficiency.

Considering the context of our research and the needs of learners/students intended to be targeted, a series of seven interrelated competencies were selected to be embedded in the curriculum for sustainability as follows:

- *Valuing ideas*: discern the value of social, cultural and economic terms; distinguish the potential of an idea for bringing value and identify suitable ways of making the most of it.
- *Creativity*: develop better solutions to existing and new challenges.
- *Ethical and sustainable thinking*: think about how Sustainable Development Goals (SDGs) are in long-term and the course of action chosen.
- *Self-awareness and self-efficacy*: think on own needs, aspirations and wants in the short, medium and long term.
- *Motivation and perseverance*: being resilient under pressure, adversity, and temporary failure.
- *Working with others*: collaboration with colleagues to develop ideas; solve conflicts and face up to competition positively.
- *Learning through experience*: take advantage of any initiative for value creation as a learning opportunity; learn from success and failure; learn with others, including peers and teachers.

The quest for learning curriculum for sustainability competencies was also addressed by careful consideration of the LifeComp competence framework which identified and described the collection of qualities required to deal with life's complexity as thriving people, responsive social agents, and reflective learners (Sala et al., 2020). It advocated for nine competencies grouped into three themes such as personal areas with self-regulation, flexibility, and well-being, social area with empathy, communication, and collaboration, as well as learning to learn areas grounded on growth mindset, critical thinking, and managing learning.

For the target group learning needs, a set of four components were considered critical to be used in didactical activities with learners (i.e. business engineering students). These were used as a common ground to foster a sustainability mindset by helping learners to acquire knowledge, skills, and attitudes to think, plan and act with empathy, responsibility and care for sustainable growth as follows:

- *Flexibility* is based on fostering digital skills by utilizing the opportunities brought about by the spread of technology and online teaching and learning, as well as students' and learners' open attitudes toward novel ideas, tools, or methods of doing things. It also depends on their capacity to deal with uncertainty.
- *Communication* stood for the ability to adjust the communication style to the online teaching format as well as the ability to listen effectively show patience and interest, clarify, and summarize the key ideas from the message. Worth mentioning is that the

communication learning outcome included active communication with students as a result of the course's online format in order to mitigate the risk brought on by people's propensities to remember and pay attention to information that supports their preexisting beliefs while ignoring information that contradicts them (i.e. confirmation bias phenomena).

- *Collaboration* by promoting group interactions, working in teams and actively co-participates in collective activities in fair relationships. These include the willingness to actively participate in achieving the shared objectives, supporting and facilitating student contributions, transferring information and resources efficiently, providing one another with feedback to improve performance on tasks and obligations, and challenging one another's conclusions and reasoning to foster deeper understanding of the issues.

- *Critical thinking* which stood for the capacity to assess information and arguments to support reasoned conclusions and develop innovative solutions. It also included the development of convergent thinking in terms of assessment, synthesis, and interpretation to address sustainability-related issues and questions and to come to a logical conclusion. The online format of the course required particular attention to the communication learning outcome by adding specific components that support the development of digital skills. As acknowledged by DigiComp 2.0, digital skills are about the confident and critical use of digital technology in five relevant areas such as information and data literacy, communication and collaboration, digital content elaboration, safety, and problem-solving (Vuorikari et al., 2016).

To this end, three competency areas gained particular relevance for curriculum for sustainability in terms of:

- *Information and data literacy* covers the whole spectrum of the managing cycle applied to digital information such as organizing, storing, analyzing and retrieving digital data, information and content.

- *Digital communication and collaboration* that stood for interacting through digital technologies with regard to collaborative processes, and co-creation of data, resources and knowledge.

- *Digital content creation* covers the development and integration of digital content in different formats and using the most appropriate digital means.

The concern for innovation and sustainable growth was addressed by a locally rooted approach that fostered a learning curriculum for sustainability, enriching teaching, improving learning experiences, and equipping students with valuable transferable skills. The envisaged curriculum articulated the series of specific learning outcomes in line with the study on students learning expectations and updated learning needs for teaching and learning for sustainable development goals (Fleacă et al., 2022).

In this regard, table 2 designates the framework with specific learning outcomes of the course built on the common conceptual frameworks fostering education for sustainability (Bacigalupo et al., 2016; Sala et al., 2020; Vuorikari et al., 2016).

**Table 2.** The framework with specific learning outcomes of the course

<b>Learning outcomes envisaged for the course</b>	<b>Description</b>
<b>Valuing ideas</b>	<ul style="list-style-type: none"> <li>• Judging the values of social, cultural and economic themes/terms</li> <li>• Recognizing the potential of ideas which create value and identifying appropriate ways of making the most out of it</li> </ul>
<b>Ethical and sustainable thinking</b>	<ul style="list-style-type: none"> <li>• Assessing the consequences and impacts of ideas, opportunities and actions</li> <li>• Reflecting on the concepts of sustainable long-term social, cultural and economic goals and related courses of actions</li> </ul>
<b>Self-awareness and self-efficacy</b>	<ul style="list-style-type: none"> <li>• Having the ability to assess personal strengths and weaknesses</li> </ul>
<b>Communication</b>	<ul style="list-style-type: none"> <li>• Use relevant communication strategies and tools, depending on the context and content</li> </ul>
<b>Collaboration</b>	<ul style="list-style-type: none"> <li>• Developing the capacity for teamwork and group activities, recognizing and appreciating people</li> </ul>
<b>Critical thinking</b>	<ul style="list-style-type: none"> <li>• Comparing, analyzing, assessing, and synthesizing data, information, ideas, and media messages in order to draw logical conclusions</li> <li>• Assessing information and arguments to support reasoned conclusions and developing innovative solutions</li> </ul>
<b>Information and data literacy</b>	<ul style="list-style-type: none"> <li>• Locate and retrieve digital data, information and content</li> <li>• Judging the relevance of the source and its content</li> <li>• Storing, managing, and organizing digital data, information and content</li> </ul>
<b>Digital communication and collaboration</b>	<ul style="list-style-type: none"> <li>• Using digital tools and technologies to facilitate collaborative processes and to mutually build knowledge, resources, and data</li> </ul>
<b>Digital content creation</b>	<ul style="list-style-type: none"> <li>• Creating and editing digital content in different formats</li> <li>• Changing content using the most appropriate digital means</li> </ul>

Table 3 designates the high-level content of the curriculum and related educational components in terms of correlation between sustainability themes, SDGs topics, and subjects taught. The content of the curriculum used a flexible approach that enabled the development of a variety of subjects-oriented teaching materials linked to foreseen SDGs and a wide range of industry examples. The methodological approaches took advantage of the digital education format (i.e. the mix of synchronous and asynchronous digital communication) exposing students to educational materials with cross-disciplinary modules and knowledge in the foreseen subjects, study cases with good practices and



examples, video materials and practical learning resources, kits with exercises and tests, and assessment resources.

**Table 3.** The correlation between sustainability themes, SDGs topics, and subjects of the curriculum

Sustainability themes	SDGs topics	Subjects taught
<b>Economic performance</b>	<ul style="list-style-type: none"> <li>SDG1. No Poverty</li> <li>SDG9. Industry, innovation and infrastructure</li> <li>SDG8. Decent work and economic growth</li> </ul>	<ul style="list-style-type: none"> <li>Green business, green finance and investments</li> <li>Economic yield of resources and sharing economy</li> <li>Innovation and responsibility for product</li> </ul>
<b>Environmental performance</b>	<ul style="list-style-type: none"> <li>SDG7. Affordable and clean energy</li> <li>SDG12. Responsible consumption and production</li> </ul>	<ul style="list-style-type: none"> <li>Circular economy – green production and waste to resource</li> </ul>
<b>Social performance</b>	<ul style="list-style-type: none"> <li>SDG8. Decent work and economic growth</li> <li>SDG10. Reduced inequalities</li> <li>SDG11. Sustainable cities and economies</li> </ul>	<ul style="list-style-type: none"> <li>Sustainable lifestyle and education</li> <li>Occupational health and safety</li> </ul>

To properly assess the effectiveness of the designed curriculum for teaching and learning for sustainability, the feedback questionnaire evaluated the fulfillment of planned learning outcomes and the degree of learners'/students satisfaction with the methodological approach of the course. The structure of the feedback survey is presented in table 4, figuring out the relationship between the survey objectives, variables, and operational terms. The questionnaire was developed using an interval scale as measurement and a 5-points Likert scale for scaling technique.

**Table 4.** The framework of the feedback survey

Survey objectives	Survey variables	Operational variables
O1. To measure the learners' satisfaction	The design of the course	<ul style="list-style-type: none"> <li>The relevance of SDGs topics against learning needs</li> <li>The usefulness of course objectives</li> <li>The structure of the course</li> <li>Communication with learners</li> </ul>
	The content of the curriculum	<ul style="list-style-type: none"> <li>The volume of information</li> <li>The workload of learning activities</li> <li>The level of complexity for the subjects</li> </ul>
	The quality of educational materials	<ul style="list-style-type: none"> <li>Teaching resources with course modules and materials for Sustainability themes (Economic, Social, and Environmental)</li> </ul>

		<ul style="list-style-type: none"> <li>• Learning Resources with practical exercises and applications for Sustainability themes (Economic, Social, and Environmental)</li> </ul>
O2. To assess the fulfilment of the learning outcomes	Valuing ideas	<ul style="list-style-type: none"> <li>• Learn to innovatively resolve responsibility issues in doing business</li> <li>• Combine knowledge and draw up conclusions on sustainability-related directions (Economic, Social, and Environmental)</li> </ul>
	Ethical and sustainable thinking	<ul style="list-style-type: none"> <li>• Gain new insights on Sustainable Development Goals – SDGs</li> <li>• Learn new techniques to solve sustainability issues and problems</li> </ul>
	Self-awareness and self-efficacy	<ul style="list-style-type: none"> <li>• Improve self-confidence, motivation and initiatives</li> </ul>
	Communication	<ul style="list-style-type: none"> <li>• Improve self-confidence, motivation and initiatives</li> <li>• Improve the learning skills</li> </ul>
	Collaboration	<ul style="list-style-type: none"> <li>• Solve problems in teams</li> </ul>
	Critical thinking	<ul style="list-style-type: none"> <li>• Gain new experience</li> <li>• Combine knowledge and draw up conclusions on sustainability-related directions (Economic, Social, and Environmental)</li> </ul>
	Information and data literacy	<ul style="list-style-type: none"> <li>• Exercise entrepreneurship and develop digital and civic skills</li> <li>• Improve the learning skills</li> </ul>
	Digital communication and collaboration	<ul style="list-style-type: none"> <li>• Exercise entrepreneurship and develop digital and civic skills</li> <li>• Improve the learning skills</li> </ul>
Digital content creation	<ul style="list-style-type: none"> <li>• Exercise entrepreneurship and develop digital and civic skills</li> <li>• Improve the learning skills</li> </ul>	

#### 4. Results and discussions

The process of collecting responses from learners was based on a feedback sheet questionnaire, via an online channel and using Google Forms functionalities. The e-survey was applied to learners at the end of each e-learning session and 85% of the learners filled in the questionnaires. For statistical analysis and the development of graphs, the author applied the MS Office programs.

To fulfill the first survey objective, the students were asked to mark their level of agreement related to the statements for measuring their satisfaction with course design, the content of the curriculum and the quality of educational materials.

As figure 1 suggests the analysis of the course design revealed that almost 80% of students positively appreciated the usefulness of the course objectives while communication during the course activities was valued by 85% of them. The vast majority of learners highly appreciated the relevance of the sustainability-related topics against their learning needs whereas only a small proportion 10% had no opinion or not agreed with these subjects (5%). Notably, the structure of the course with regard to sustainability themes, SDGs topics, subjects of the curriculum and the methodological approach (i.e. mix between synchronous and asynchronous digital communication) were fully appreciated by 45%, agreed by only 30% whereas almost 25% had no opinion on this matter.

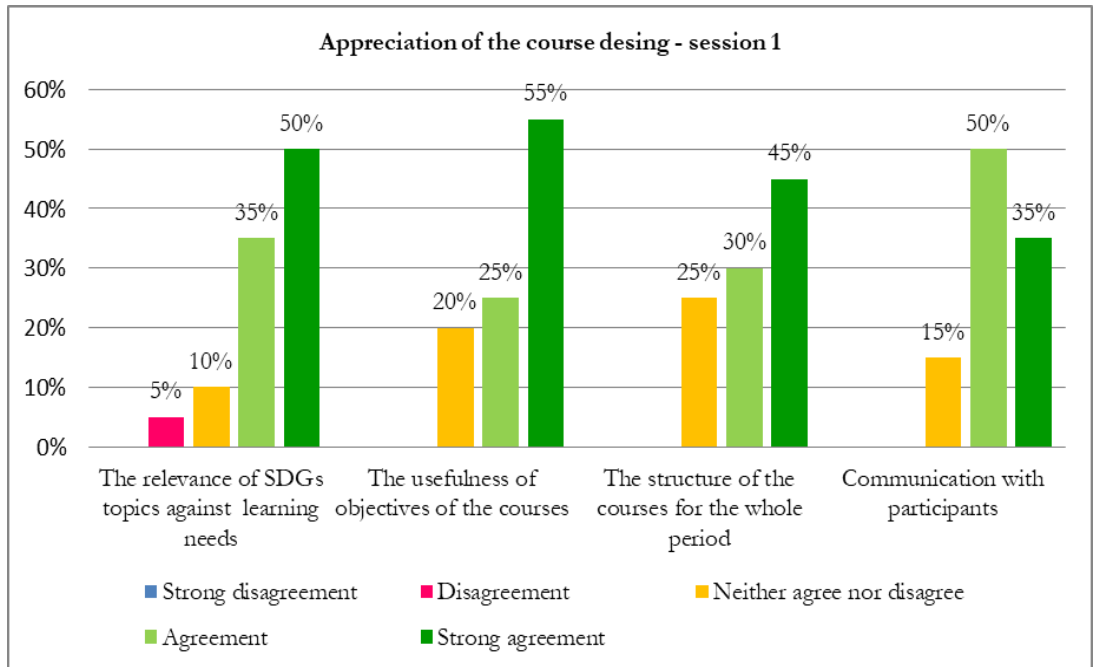


Fig. 1. The distribution of responses for the survey variable: course design – 1<sup>st</sup> session

Source: "Authors' analysis"

The data analysis of the 2<sup>nd</sup> session reveals an improved appreciation with particular regard to the following aspects (figure 2):

- the usefulness of the course objectives was strongly appreciated by 65%, a good appreciation by 20% of the students while a small proportion of 15% did not have any opinion; communication was highly valued by 65% and appreciated by 35% of them;
- the structure of the course received a strong positive appreciation of 55% and a good appreciation of 45% of them; the relevance of sustainability-related topics was strongly appreciated by 75% and appreciated by 25% of them.

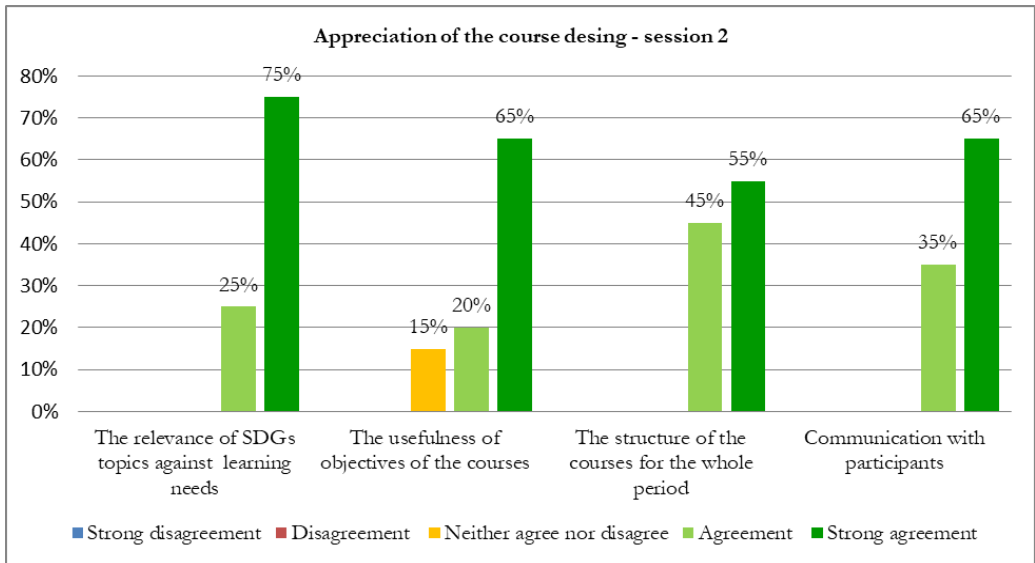


Fig. 2. The distribution of responses for the survey variable: course design – 2<sup>nd</sup> session

Source: "Authors' analysis"

Looking at the content of the curriculum (figure 3), the analysis of feedback responses from the 1<sup>st</sup> session revealed that the workload has been mostly appreciated as excellent by 45% and good by 30% whereas only a small part of 20% did not appreciate. Albeit, there is 15% of students marked a negative appreciation, though the level of complexity for the subjects taught received a good evaluation by 50% and excellent by 25% of the learners. The volume of information tends to be appreciated as good by 25% and excellent by 45% even though 20% did not value this aspect.

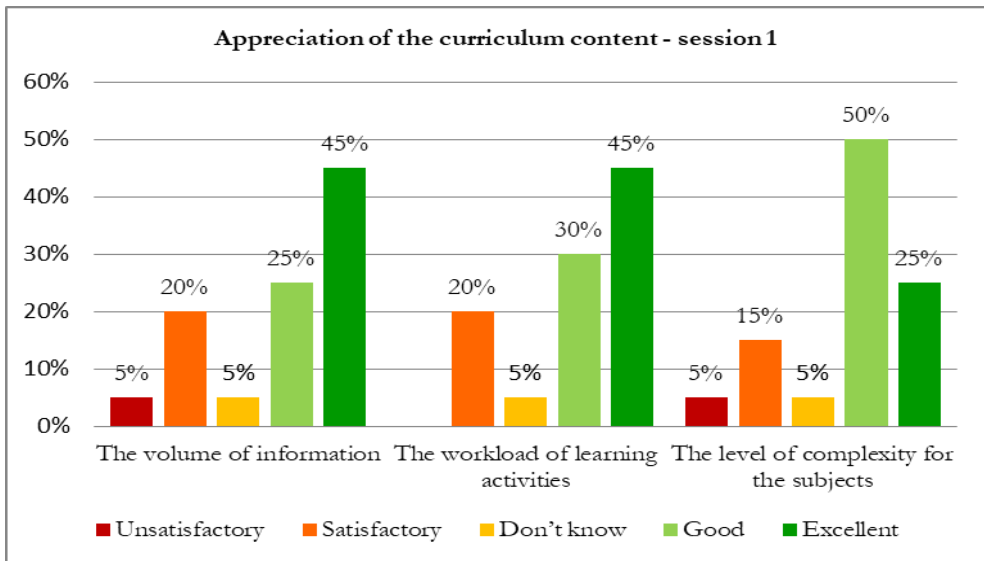


Fig. 3. The distribution of responses for the survey variable: curriculum content – 1st session  
Source: "Authors' analysis"

As regards the 2<sup>nd</sup> session, the feedback was improved considering the following aspects (figure 4):

- the workload of learning activities received only positive appreciation being marked as good by 55% and excellent by 45% of them;
- the complexity of the subjects received only positive appreciation being marked as good by 45% and excellent by 55% of them;
- the volume of information received an increased positive appreciation being considered excellent by 60%, and good by 15% whilst 25% of learners had no opinion on this matter.

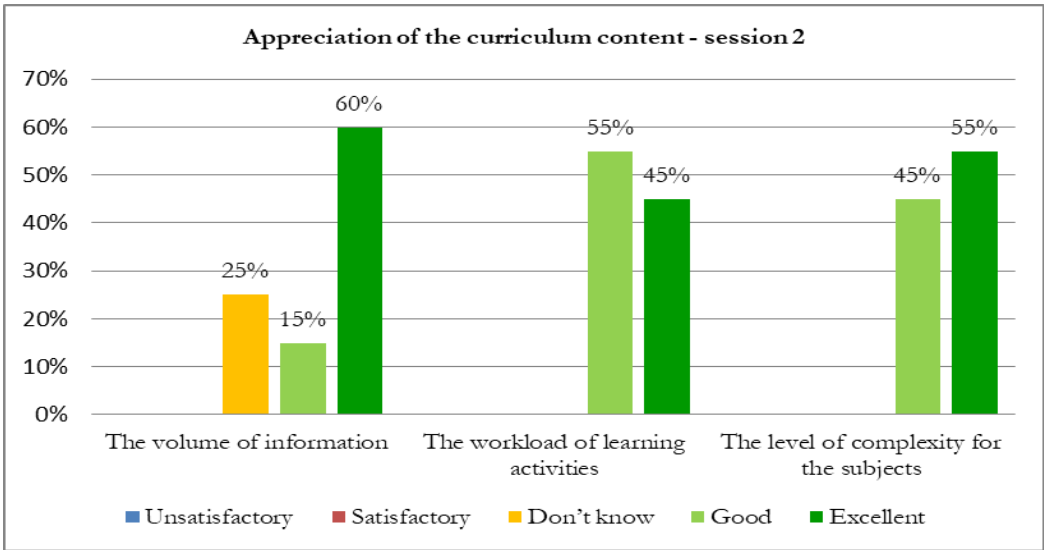


Fig. 4. The distribution of responses for the survey variable: curriculum content – 2nd session  
 Source: "Authors' analysis"

The learners' satisfaction with regard to the quality of educational materials has been improved from one session to another. As presented in figures 5 and 6, several improvements in teaching resources are worth to be mentioned:

- Economic subjects (e.g. green business, investments and green finance; efficiency of resources through sharing economy; and innovation and responsibility for product) received higher scores, being positively appreciated by 75% of learners versus only 45% in the 1<sup>st</sup> session;

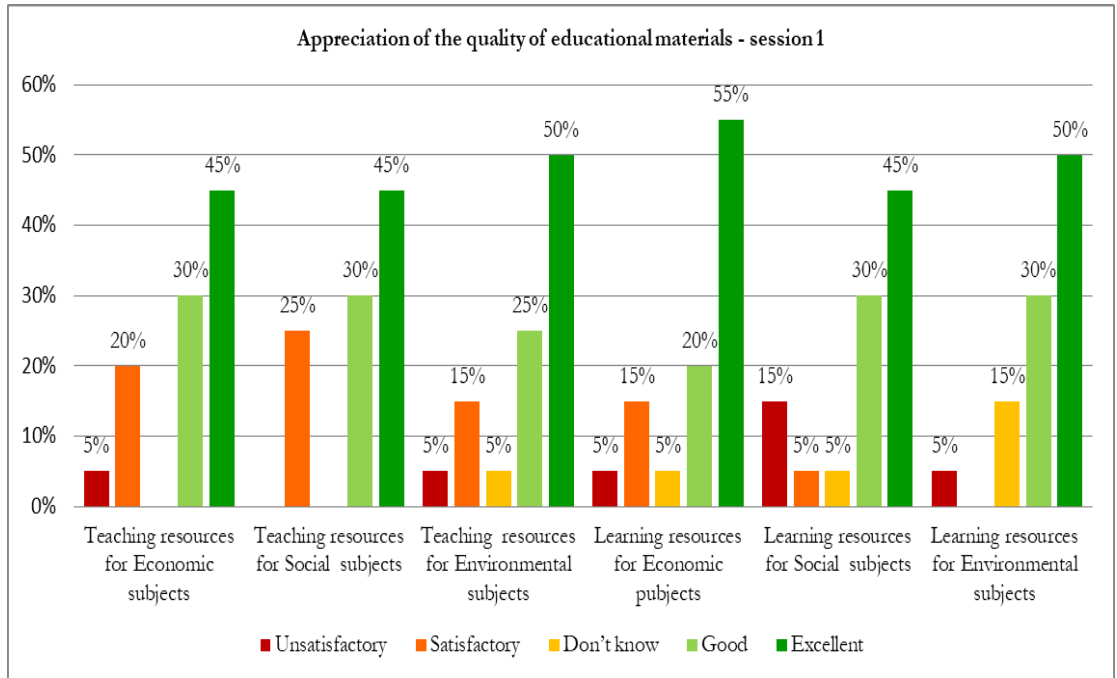


Fig. 5. The distribution of responses for the survey variable: quality of educational materials – 1<sup>st</sup> session  
Source: "Authors' analysis"

- Social subjects (e.g. sustainable lifestyle and education; occupational health and safety) received higher scores, being positively appreciated by 85% of learners compared to only 45% in the 1<sup>st</sup> session;
- Environmental subjects (e.g. circular economy – green production and waste to resources) encountered an increased appreciation of 75% of learners versus 50% in the 1<sup>st</sup> session.

The learning resources (i.e. study cases, quizzes, exercises, applications, video materials, etc.) used to support the acquisition of hands-on knowledge and skills in a wide range of sustainability-related subjects received better evaluation scores from one session to another as follows:

- Economic subjects were marked as good and excellent by 75% of the learners in the 1<sup>st</sup> session to 90% in the 2<sup>nd</sup> session;
- Social subjects were marked as good and excellent by 75% of the learners in the 1<sup>st</sup> session to 100% in the 2<sup>nd</sup> session;
- Environmental subjects were marked as good and excellent by 80% of the learners in the 1<sup>st</sup> session to 100% in the 2<sup>nd</sup> session.

The improved values of the surveying variables (i.e. course design, curriculum content, quality of educational materials) were ensured based on the ongoing improvement cycle which enabled testing the course (i.e. session 1), feedback collection, adjusting the content

of the curriculum and related educational components in terms of correlation between sustainability themes, SDGs topics, and subjects taught as well as delivering the improved version (i.e. session 2) to the new series of students from the business engineering specialization.

As regards the second survey objective, the analysis of learning outcomes for the 1st session (table 5) figured out a weighted score of 4.4 for solving problems in teams, gaining new experiences and improvement of self-confidence, motivation and initiative. The least appreciated outcomes seem to be exercising entrepreneurship and developing digital and civic skills (3.8) and learning to innovatively resolve responsibility issues in doing business (3.8).

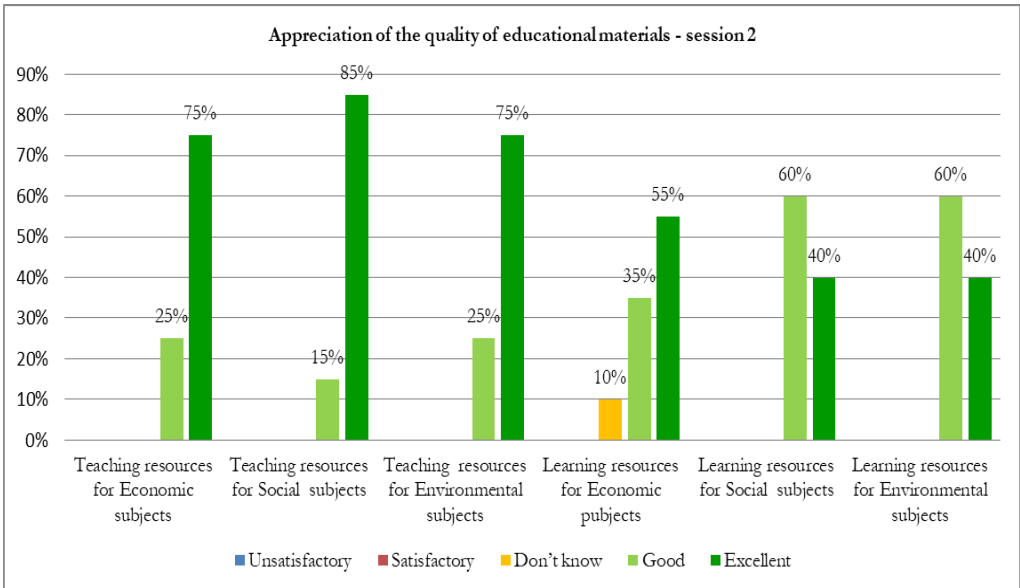


Fig. 6. The distribution of responses for the survey variable: quality of educational materials – 2<sup>nd</sup> session  
Source: "Authors' analysis"

Overcoming the communication barriers and disruptions induced by the pandemic crisis and the shift of education from a physical to an entirely digital format stand for the reasons supporting these findings. The methodological approaches for delivering the 1<sup>st</sup> session were mainly focused on strengthening digital strategies and tools, increasing the student's ability to work in teams to resolve their digital assignments as well as supporting the logical reasoning, evaluation, analysis, synthesis and interpretation to innovatively solve sustainability-related problems and questions.

**Table 5.** The student’s assessment: learning outcomes for the course – 1<sup>st</sup> session.

Learning outcomes assessments	Not at all achieved (1 pct.)	Not achieved (2 pct.)	Somewhat extent (3 pct.)	Achieved (4 pct.)	Fully achieved (5 pct.)	Weighted score



Gain new insights on Sustainable Development Goals – SDGs	1	0	0	10	9	<b>4.3</b>
Learn new techniques to solve sustainability issues and problems	0	1	1	10	8	<b>4.25</b>
Improve the learning skills	0	0	4	6	10	<b>4.3</b>
Solve problems in teams	0	0	2	8	10	<b>4.4</b>
Combine knowledge and draw up conclusions on sustainability directions	0	0	2	9	9	<b>4.35</b>
Gain new experience	0	0	3	6	11	<b>4.4</b>
Improve self-confidence, motivation and initiatives	0	0	3	6	11	<b>4.4</b>
Exercise entrepreneurship and develop digital and civic skills	0	2	5	8	5	<b>3.8</b>
Learn to innovatively resolve responsibility issues in doing business	0	2	6	6	6	<b>3.8</b>

The analysis of the 2<sup>nd</sup> session (table 6) pinpointed a slight change in the learning outcomes since learners were more likely to appreciate the achievement of gaining new insights on Sustainable Development Goals – SDGs (4.7), followed by solving problems in teams (4.65) and improvement of the learning skills (4.65). These findings advocate for certain improvements with regard to students' ethical and sustainable thinking, enhancement of the concept of sustainability and consequences as well as the ability to use relevant communication strategies and tools, especially in group activity and digital teamwork assignments.

**Table 6.** The student's assessment: learning outcomes for the course – 2<sup>nd</sup> session.

<b>Learning outcomes assessments</b>	Not at all achieved (1 pct.)	Not achieved (2 pct.)	Somewhat extent (3 pct.)	Achieved (4 pct.)	Fully achieved (5 pct.)	Weighted score
Gain new insights on Sustainable Development Goals – SDGs	0	0	0	6	14	<b>4.7</b>

Learn new techniques to solve sustainability issues and problems	0	0	0	17	3	<b>4.15</b>
Improve the learning skills	0	0	0	7	13	<b>4.65</b>
Solve problems in teams	0	0	0	7	13	<b>4.65</b>
Combine knowledge and draw up conclusions on sustainability directions	0	0	3	11	6	<b>4.15</b>
Gain new experience	0	0	0	11	9	<b>4.45</b>
Improve self-confidence, motivation and initiatives	0	0	3	11	6	<b>4.15</b>
Exercise entrepreneurship and develop digital and civic skills	0	2	6	6	6	<b>3.8</b>
Learn to innovatively resolve responsibility issues in doing business	0	0	2	12	6	<b>4.2</b>

When it comes to comparing the evaluation scores from one session to another, the findings supported the added value of the curriculum which induced positive changes through the fulfillment of the following learning outcomes:

- The improvement in gaining new insights on Sustainable Development Goals – SDGs steered toward the enhancement of ethical and sustainable thinking;
- The improvement of the learning skills mainly led to the increased degree of communication, information and data literacy, digital communication and collaboration, as well as digital content creation;
- The improvement in learning to innovatively resolve responsibility issues in doing business mainly led to an increasing extent of valuing ideas;
- The improvement of self-confidence, motivation and initiative steered toward the development of self-awareness and self-efficacy;
- Solving problems in teams which contributed to the development of collaboration ability;
- Gaining new experiences and combining knowledge to draw up conclusions on sustainability-related directions that have supported critical thinking and the ability to coherently link concepts, ideas, and facts and figures.

In concluding remarks, the findings highlighted significant benefits for students from business engineering education attending the innovative course curriculum for sustainability, framed by sustainable development concerns, which stimulated the

acquisition of knowledge, skills, and attitudes toward sustainability. Also, through the tailored content and quality information covering economic, environmental and social pillars of sustainable development, this proved to be a valuable methodological tool to change the status quo, to improve teaching and learning for sustainability, enabling a better alignment of curricula outcomes in the area of business engineering education.

However, the limitation of the survey should be noted in terms of the small sample size, space, and timeframe of the research which requires further extending the boundary of study to other students from other engineering specializations and/or faculties as well as to graduate students. This will help to identify valuable actions for reinforcing teaching and learning practices through curriculum design for sustainability.

## 5. Conclusion

There is a reasonable need for an equitable approach of all three dimensions of economic, environmental, and social aspects to be integrated into the curriculum in an effort to deal with the complicated problems of sustainability education in order to provide knowledge and practices to creatively solve business sustainability-related problems.

This prompted the necessity to equip students with a deeper comprehension of complex issues related to sustainability and their evolution as well as the ability to connect ideas, concepts, facts, and data in order to fully comprehend the reality in relation to other contexts (local, national, and global) and fields (environmental, social, economic, and cultural).

Key sustainability skills are interconnected with and related to academic competence, which can be attained in any academic setting (Wiek, Withycombe & Redman, 2011). Our results advocate for the integration of the content of the curriculum centered on citizenship and sustainable development goals into the current institutional teaching and learning practices, enabling mainstreaming of the sustainable dimension of education. These are also supported by new studies that call for incorporating the principles of education for sustainable development into all levels of education. These studies see the incorporation of sustainability-related issues into extracurricular activities as a promising learning opportunity to best encourage students to make decisions (Cebrián & Mulà, 2020). As our findings suggested, the satisfaction of learners has been increased from one session to another thanks to the ongoing improvement cycle of course design, curriculum content, and the quality of educational materials. Acquiring sustainable attitudes and values are integral to developing knowledge as endorsing and supporting societal and human values that promote social capital and societal well-being, framing the priorities for what comprises good citizenship (Haste, 2018). Notably, digital communication and collaboration are becoming increasingly essential for the intellectual maturity of learners (i.e. students), especially in the context of the expansion of digitalization into all areas of life (OECD, 2018). In addition, in the era of digital transformation, information and data literacy requires the ability to evaluate critically and filter information that is easily produced, accessed, and made public. It also requires the capacity to deal with large amounts of data and to combine and apply knowledge, skills, attitudes, and values in an increasing variety of contexts and unfamiliar circumstances which is uniquely human (Luckin & Issroff, 2018). The accomplishment of learning outcomes (i.e. valuing ideas

ethical and sustainable thinking, self-awareness and self-efficacy, communication, collaboration, critical thinking, information and data literacy, digital communication and collaboration, and digital content creation) has resulted in significant opportunities for interactive learning with a positive impact on students.

A practical solution that assisted business engineering students in transferring knowledge from one context to another by integrating, connecting, confronting, and reconciling various worldviews was provided by the curriculum and educational components, which combined sustainability themes, SDGs topics, and appropriate subjects taught. As argued by Bianchi (2020), the integrative approach reflects a necessary requirement given the inherently complicated nature of sustainability.

The set of educational materials (i.e. cross-disciplinary modules and knowledge in the foreseen subjects, study cases with good practices and examples, video materials and practical learning resources, kits with exercises and tests, and assessment resources) supported the fulfillment of learning objectives of the course and therefore represented a good pattern of curriculum work that offered new opportunities for teaching and learning sustainability. An increasing number of sustainable development topics and the involvement of teaching staff, as suggested by previous attempts, may raise awareness of sustainability issues, which is crucial for strengthening the knowledge, skills, and attitudes necessary to live, work, and act sustainably (Badea et al., 2020).

Our results should also be interpreted as a locally rooted solution for sustainability in education curricula in the business engineering field which promoted the latest knowledge and practices for sustainable development. As UNESCO (2020) also emphasized, localized transformative actions for sustainable development are of utmost importance for the meaningful transformation of learning settings and for providing opportunities for all learners to become change agents.

Even with an increased focus on specific learning outcomes, our results argued for an innovative approach to sustain transversal skills development which is not tied to any particular technical and/or business subject and may be developed in all areas of study (OECD, 2021). On a broader sense, our findings provide a simplified example of how the curriculum design (i.e. the flow of the course learning objectives, the specific learning outcomes of the course, and the correlation between sustainability themes, SDGs topics, and subjects taught) can foster sustainability learning outcomes in the case of business engineering education. Also, given the digital format in which the courses were delivered, the lessons learned advocated for enhanced students' digital readiness in terms of digital communication and collaboration as well as digital content creation by refining, improving and integrating information and knowledge into the existing body of knowledge to create new and relevant content and sustainability-related knowledge.

Albeit the scope of the survey is limited to a small number of respondents (i.e. the students as beneficiaries involved in testing and adjusting the curriculum) this might add helpful insights on how to provide learners with useful knowledge on various sustainability-related subjects, reaping the benefits of digitization and collaborative learning practices. The results can be a valuable reference for use in future work, and also may serve as an aid to future practices toward teaching and learning for sustainability outcomes. The curriculum content and methodological approach may be used and adjusted in different educational

settings boosting synergies with other initiatives of a similar nature in other institutional and national contexts.

## References

- Al-Bahi, A. M., Abd-Elwahed, M. S., & Soliman, A. Y. (2021). Implementation of Sustainability Indicators in Engineering Education Using a Combined Balanced Scorecard and Quality Function Deployment Approaches. *Sustainability*, 13(13), 7083. [doi.org/10.3390/su13137083](https://doi.org/10.3390/su13137083)
- Bacigalupo, M., Kamylyis, P., Punie, Y., & Van Den Brande, L. (2016). *EntreComp: The Entrepreneurship Competence Framework*. EUR 27939 EN. Luxembourg: Publications Office of the European Union. JRC101581.
- Badea, L., Șerban-Oprescu, G. L., Dedu, S., & Piroșcă, G. I. (2020). The Impact of Education for Sustainable Development on Romanian Economics and Business Students' Behavior. *Sustainability*, 12(19), 8169. <https://doi.org/10.3390/su12198169>
- Bianchi, G. (2020). *Sustainability Competences*. EUR 30555 EN. Luxembourg: Publications Office of the European Union. JRC123624. doi:10.2760/200956
- Cebrián, G., Junyent, M., & Mulà, I. (2020). Competencies in Education for Sustainable Development: Emerging Teaching and Research Developments. *Sustainability*, 12(2), 579. <https://doi.org/10.3390/su12020579>
- Elsaadany, A., & Helmi, A. (2018). Sustainable Development, Technological and Industrial Impacts on Engineering Education. *Interdisciplinary Description of Complex Systems*, 16(2), 227–237. doi: [10.7906/indecs.16.2.3](https://doi.org/10.7906/indecs.16.2.3)
- European Commission. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. (2020). *European Skills Agenda for sustainable competitiveness, social fairness and resilience*. COM(2020) 274 final.
- European Commission. *Proposal for a Council Recommendation on learning for environmental sustainability*. COM(2022) 11 final.
- Fleacă, B., Fleacă, E., & Corocăescu, M. (2022). Reshaping Teaching for Sustainability in Business Engineering – A Pilot Study on Students' Outlooks and Learning Expectations. *European Journal of Sustainable Development*, 11(3), 226-246. [doi.org/10.14207/ejsd.2022.v11n3p226](https://doi.org/10.14207/ejsd.2022.v11n3p226)
- Gadușovă, Z., Jakubovská, V., Markechová, D., Tírpáková, A. (2019). Teacher Competences Development – a Guarantee of Sustainable High Level of Education and Training. *TEM Journal*, 8(3), 1063-1070. DOI: 10.18421/TEM83-52
- Galtseva, T., Svitich, S., Kutsiy, A., Savchenko, V., & Strukova, T. (2020). Education for Sustainable Development in the Value System of Teachers. *European Journal of Sustainable Development*, 9(4), 147-160. [doi.org/10.14207/ejsd.2020.v9n4p147](https://doi.org/10.14207/ejsd.2020.v9n4p147)
- Geitz, G., & de Geus, J. (2019). Design-based education, sustainable teaching, and learning. *Cogent Education*, 6(1), 1647919. DOI: 10.1080/2331186X.2019.1647919
- Haste, H. (2018). Attitudes and Values and the OECD Learning Framework 2030: A critical review of definitions, concepts and data. OECD, Retrieved from [https://www.oecd.org/education/2030-project/contact/Draft\\_Papers\\_supporting\\_the\\_OECD\\_Learning\\_Framework\\_2030.pdf](https://www.oecd.org/education/2030-project/contact/Draft_Papers_supporting_the_OECD_Learning_Framework_2030.pdf)
- Lai, Y.-C., & Peng, L.-H. (2019). Effective Teaching and Activities of Excellent Teachers for the Sustainable Development of Higher Design Education. *Sustainability*, 12(1), 28. [doi.org/10.3390/su12010028](https://doi.org/10.3390/su12010028)
- Luckin, R., & Issroff, K. (2018). Education and AI: preparing for the future. OECD, Retrieved from <https://www.oecd.org/education/2030-project/about/documents/Education-and-AI-preparing-for-the-future-AI-Attitudes-and-Values.pdf>.

- Neves, R. M., Lima, R. M., & Mesquita, D. (2021). Teacher Competences for Active Learning in Engineering Education. *Sustainability*, 13(16), 9231. doi.org/10.3390/su13169231
- Nikolić, V. M.; Vukić, T. M. (2021). Sustainable development as a challenge of engineering education. *Thermal Science*, 25(3A), 1921-1933. doi: [10.2298/TSCI200726304N](https://doi.org/10.2298/TSCI200726304N)
- OECD (2021). *OECD Skills Outlook 2021: Learning for Life*. Paris: OECD Publishing. doi.org/10.1787/0ac365b4-en
- OECD (2018). *Education 2030: The Future of Education and Skills*. Position paper, OECD, Retrieved from [http://www.oecd.org/education/2030/E2030%20Position%20Paper%20\(05.04.2018\).pdf](http://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf).
- Sala, A., Punie, Y., Garkov, V., & Cabrera Giraldez, M. (2020). *LifeComp: The European Framework for Personal, Social and Learning to Learn Key Competence*. EUR 30246 EN. Luxembourg: Publications Office of the European Union. JRC120911. doi:10.2760/302967
- Sánchez-Carracedo, F., Segalas, J., Bueno, G., Busquets, P., Climent, J., Galofré, V. G., Lazzarini, B., Lopez, D., Martín, C., Miñano, R., Cámara, E. S. de, Sureda, B., Tejedor, G., & Vidal, E. (2021). Tools for Embedding and Assessing Sustainable Development Goals in Engineering Education. *Sustainability*, 13(21), 12154. <https://doi.org/10.3390/su132112154>
- Tassone, V.C., O'Mahony, C., McKenna, E., Eppink, H.J., & Wals, A. E. J. (2018). Re-designing higher education curricula in times of systemic dysfunction: a responsible research and innovation perspective. *Higher Education*, 76, 337–352. doi.org/10.1007/s10734-017-0211-4
- United Nations Educational, Scientific and Cultural Organization (UNESCO). (2020). *Education for Sustainable Development Goals: a roadmap*. UNESCO, Paris, France. Retrieved from <https://unesdoc.unesco.org/ark:/48223/pf0000374802>
- Venezia, E., & Pizzutilo, F. (2022). EffSET: a Self-Evaluation Tool to Assess the Effectiveness of Education for Sustainable Development. *European Journal of Sustainable Development*, 11(4), 197-210. <https://doi.org/10.14207/ejsd.2022.v11n4p197>
- Vuorikari, R., Punie, Y., Carretero Gomez S., Van den Brande, G. (2016). *DigComp 2.0: The Digital Competence Framework for Citizens. Update Phase 1: The Conceptual Reference Model*. Luxembourg: Publication Office of the European Union. EUR 27948 EN. doi:10.2791/11517
- Wiek, A., Withycombe, L., & Redman, C.L. (2011). Key competencies in sustainability: a reference framework for academic program development. *Sustainability Science*, 6(2), 203–218. doi.org/10.1007/s11625-011-0132-6
- WBCSD. World Business Council for Sustainable Development (2021). *Vision 2050. Time to transform*. Retrieved from <https://www.wbcsd.org/contentwbc/download/11765/177145/1>