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Sustainable entrepreneurship education for circular economy: emerging perspectives in Europe

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Abstract

Purpose – The paper aims to contribute to the Circular Economy debate from the Entrepreneurship Education perspective. Despite scholars' growing interest in both these research streams, scarce consideration is given to the comprehension of their mutual implications and meaning.

Design/methodology/approach – The paper is based on a cross-case analysis. It compares 16 higher education programmes launched by Universities in Europe aimed to create competences and skills for Circular Economy in students with different profiles. The analysis provides a critical view of the emerging trends for the entrepreneurship education skills and competencies needed for the emerging circular entrepreneurship paradigm.

Findings – The paper discusses the main trends of Entrepreneurship Education focused on Circular Economy debate at the European level: rationale and learning objectives (why); contents (what), target students and stakeholders (who) and the learning processes (how). Four thematic areas are identified as common patterns: circular economy business model, green supply chain management, technology entrepreneurship and innovation and public policies and institutional frameworks.

Research limitations/implications – The paper sheds new light on a still under-researched area, suggesting several implications and avenues for future research in Circular Economy and Entrepreneurship Education. Limitations regard the need to analyse education programmes from a larger geographical area, to take into consideration interesting experiences in the rest of the world and to also collect quantitative data.

Practical implications – Practical implications arise for the development of learning initiatives for the Circular Economy: learning objectives and new thematic areas focused on circular, sustainable and innovative rethinking of the process for creating value in the incumbent companies; exploring meaning and benefits of collaborative approaches and participation in the circular economy innovation ecosystem and developing advanced models for soft-skills development in terms of leadership, motivational and creative skills.

Originality/value – The debate on CE can also be rooted in the paradigm of entrepreneurship as a core process to advance knowledge on valuable and sustainable innovation.

Keywords Entrepreneurship education, Circular economy, Human capital, Sustainable entrepreneurship, Europe

Paper type Research paper



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1. Introduction

Circular Economy (CE) is a topic trend of growing interest in the public debate (Urbinati *et al.*, 2017; Lahti *et al.*, 2018; Centobelli *et al.*, 2020; Ferasso *et al.*, 2020). Aimed to promote sustainable production and consumption models able to close resource loops (Ghisellini *et al.*, 2016; Moggi *et al.*, 2018), CE has been recently proposed as an alternative paradigm for socio-economic development and a promising base for achievement of sustainable development goals (Schaltegger and Wagner, 2011; Centobelli *et al.*, 2020). Companies, universities and research centres, institutions and citizens are called to contribute to the transition process of production, distribution and consumption systems toward a circular configuration. This highlights the timeliness of CE in different research fields (Murray *et al.*, 2017; Del Vecchio *et al.*, 2021; Ricciardi *et al.*, 2020). These new CE dynamics have started receiving increasing attention in the scholarly literature, including both engineering and natural science perspectives on one hand, and social sciences perspectives on the other (Tukker, 2015; Sauvé *et al.*, 2016; Blomsma and Brennan, 2017; Kirchherr *et al.*, 2017; Merli *et al.*, 2018). Supranational and international organizations such as the European Commission or Ellen MacArthur Foundation are actively involved in the promotion of CE approaches and principles in different sectors, from industrial design to manufacturing, consumption and also for education and training. Their recommendations and action plans underline the needs of human capital for the circular economy. According to the Ellen MacArthur Foundation (2015), CE represents a growth model by operating a more rational management of resources used in economic activities and designing new and alternative paths for waste creation and management, generating social and economic benefits.

However, the research in this field has reserved little attention for the implications and meaning of CE from the entrepreneurship point of view (Del Vecchio *et al.*, 2021), forgetting that the expected processes suggested by CE principles can be conceived and implemented in businesses, incumbents or start-up companies. Consequently, CE and entrepreneurship arise as paradigms intrinsically connected; indeed, implementing the first, in terms of innovative products and processes, requires the presence of human capital with the suitable competence for entrepreneurship development, and the latter needs to be more focused on the sustainability of value creation proposed by the CE to survive and remain competitive (Frishammar and Parida, 2019; Ünal *et al.*, 2019).

These considerations allow assuming that the debate on CE, therefore, can also be rooted in the paradigm of entrepreneurship as a core process to advance knowledge on technical domains for valuable and sustainable innovation. Looking at CE from the entrepreneurship perspective means investigating the dynamics related to the innovation process supporting the creation of innovative entrepreneurship as well as the competencies of human capital called to depict and implement the transition process required by the CE (Kirchherr and Piscicelli, 2019). This requires developing integrated learning programmes able to mix the different perspectives of CE to overcome fragmentation of the initiatives that until now were focused on specific aspects such as design thinking or engineering issues.

In this perspective, entrepreneurship education (EE) arises as a useful perspective for creation of innovative competencies and mindsets for the Circular Economy. It promotes experiential learning processes able to integrate knowledge from the domain of business management and technology management. Universities play a key role in addressing EE, which, according to OECD (OECD/EC, 2013), is a way of developing an entrepreneurial mindset in talented young people through the adoption of entrepreneurial learning processes. Several EE Programmes are being established, in particular with reference to academic education (Solomon, 2007; Fretschner and Weber, 2013; Fiore *et al.*, 2019; Secundo *et al.*, 2020; Toniolo *et al.*, 2020) in an effort to equip students with the knowledge and competence needed to create economic value, but above all to create entrepreneurial mindsets (Gibb, 2011; Matlay, 2011; O'Connor, 2013; Duval-Couetil, 2013; Hoppe, 2016; Lackéus and Williams Middleton,

2015; Pittaway *et al.*, 2020). Recently, in the wake of the rapid development of new technologies, an expansion of EE to other disciplines and departments has been considered (ranging from humanities to engineering, from social science to biology) crucial for developing skills, competencies and mindsets required to launch and develop high-growth, technology-based businesses (Boocock *et al.*, 2009; Secundo *et al.*, 2020). Significant growth in the curricula and programmes devoted to entrepreneurship and new venture creation arises among all sectors, and in all levels of education and for students in different fields, including humanities, arts and creative studies (Ndou *et al.*, 2018) as well as in the domain of engineering, high-tech, advanced technologies (Miranda *et al.*, 2020; Secundo *et al.*, 2020). Furthermore, expected skills and competencies to face the challenges of the CE (Ferraro *et al.*, 2015), may vary significantly, depending on whether the students are young graduates or experienced managers, prospect designers or prospect policy-makers, etc. involved in different types of educational programmes (ranging from workshops of a few days to full-time three-year programmes) (Nunes *et al.*, 2018).

These EE trends are in line with the emerging competence creation needs for the Circular Economy paradigm. Research-intensive universities are the most suited to provide “out of the box” solutions to complex sustainable societal problems. The combination of several disciplines allows them to provide advanced knowledge for facing the challenges of society’s development, while stimulating their students to the context of interdisciplinary teamwork (Fyen *et al.*, 2019).

Despite this, literature lying at the intersection of the field of EE and CE is completely missing and the different sustainability perspectives associated with business’s transition toward a circular economy configuration is very fragmented. This negligence is surprising, considering repeated arguments that “education is the key intervention for bringing change in knowledge, values, behaviours and lifestyles [...] required to achieve sustainable development” (Pandey and Vedak, 2010, p. 3; see also Berryman and Sauvé, 2016).

To cover the mentioned gap, this paper aims to demonstrate EE’s relevance as a practical lens to develop the most suitable human capital for facing the challenging coming from the CE paradigm. The research question we intend to answer is:

RQ1. How do Universities structure Entrepreneurship Education (EE) programmes for developing entrepreneurial competences and mindset for Circular Economy (CE)?

This is achieved through a cross-case analysis of 16 education programmes focused on the field of European Universities, by examining five key dimensions of learning initiatives: rationale and Learning objectives (why), contents (what), target students and stakeholders (who), learning processes (how). Empirical evidence highlights skills and competencies developed in different target students for sustainable entrepreneurship and circular entrepreneurship. Critical analysis reveals that these skills and capabilities are likely needed not only for proper start-up and/or business owners, but also for managers, designers, project managers engaged in entrepreneurial organizations facing CE transitions. In addition, policy-makers and people working in institutions are also likely to play a key role in the entrepreneurship-driven transition to CE models.

The remainder of the paper is structured as follows: Section 2 analyses the literature background around the pillars of human capital development and EE for CE. Section 3 presents the research methodology. ‘Findings’ present the main results emerging from the study while discussions describe their implications for theory and practice. Finally, the conclusions note the paper’s main contributions, its limitations and scenarios for future development.

2. Literature background

2.1 Circular economy and entrepreneurship: lying at the foundation

The CE’s main objective is to promote the integration of economic activities and intelligent model of growth through a set of conceptual models inspired by the principles of

entrepreneurial economy characterized by non-linear patterns of development and exponential growth rate (Thurik, 1999; Audretsch and Thurik, 2001). With a focus on the industrial domain of application, the studies on CE and Entrepreneurship reserved particular attention to the issue of waste management (Worthington and Downey, 2019), waste management in the textile (Staicu and Pop, 2018), construction and metals industries (Vegea *et al.*, 2018) or electronic equipment (Rosa *et al.*, 2019). According to Dam *et al.*, (2020), industrial design contributes to CE in four areas: circular production processes, circular consumption, policy support and education for CE.

Another industrial domain of interest is identifiable as agri-food, in terms of circular agriculture (Zhu *et al.*, 2019), agrobiodiversity (van Bueren *et al.*, 2018), food network (Reckinger, 2018) and bio-refinery in agriculture (Viaggi, 2015). Further areas of interest are represented by bioenergy (Nibbi *et al.*, 2019), water systems (Makropoulos *et al.*, 2018), logistic (Tetsman, 2017), chemical and work environment (Pääkkönen and Koponen, 2017) and raw materials (Pirard and Greberg, 2016).

As for the entrepreneurship field, most contributions are related to the definition of boundaries and blocks of sustainable business models (Nosratabadi *et al.*, 2019). A further perspective is related to social entrepreneurship (Hossain *et al.*, 2017) as a value creation process based on ethics and no profit but also characterized as entrepreneurial process with social implications as in the case of the Romanian textile sector (Staicu and Pop, 2018), social resilience and innovative entrepreneurial models for agro-biodiversity (van Bueren *et al.*, 2018), social innovation (Larsson, 2018) and ethical entrepreneurship for sustainable localized food sovereignty (Reckinger, 2018).

As highlighted by Sarango-Lalangui *et al.* (2018), the sustainable entrepreneurship issue has received great attention in the literature and contributions from different perspectives. According to Hesselbarth and Schaltegger (2014), sustainable entrepreneurs act as change agents, as they assume sustainability as a key success factor in their working environment, integrate sustainability criteria into business processes and transfer the vision of sustainable development to society (Hesselbarth and Schaltegger, 2014). Furthermore, several scholars (Patzelt and Shepherd, 2011; Cresta, 2015) highlight the concepts of opportunity recognition, longevity, sustainable development, social and environmental responsibility also with reference to traditional industries (Cantino *et al.*, 2017).

2.2 Competences and skills for circular economy

Competencies required in the sustainable context are complex and entail far more than just topical or issue-related knowledge; for instance, on environmental, business, legal or social issues. Literature underlined the need to revise current curricula to include the principles and approaches related to the CE for product design, co-creation, management and marketing (Dam *et al.*, 2020; EC, 2021).

Analysing the literature focused on sustainability entrepreneurship (SE) and education sustainability development (ESD), we noticed that the key competencies framework has received increasing attention as critical pillars for developing curricula and courses. Several scholars such as Wiek *et al.* (2011); Barth and Michelsen (2013); Lans *et al.* (2014); Wesselink *et al.* (2015); Cantino *et al.* (2017); Ploum *et al.* (2018); Focrier and Wiek (2019); Jelonek and Urbaniec (2019), provide a converging set (numerous elements in common) of key competencies required in the sustainability field. Efforts in defining various frameworks derive from the following aspects: the need to educate different sustainability professionals as change agents for sustainable development, start-up and/or business owners, but also for project managers engaged in entrepreneurial organizations facing CE transitions; spreading sustainability as a factor of success in their working environment, integrating sustainability criteria into business processes and finally transferring the vision of sustainable

development to society (Ploum *et al.*, 2019; Sumter *et al.*, 2020). Vuorio *et al.* (2018) analyse the drivers of entrepreneurial intentions across entrepreneurship types, particularly in sustainable entrepreneurship, focusing on attitudes.

Wiek *et al.* (2011) undertook a broad literature review of sustainability competencies in higher education, and later synthesized a set of key competencies in sustainability education underlying on how to operationalize them for use in curricula and courses (Wiek *et al.*, 2015). The competences are categorized around seven CE competencies for design (Sumter *et al.*, 2020): (1) Circular Impact Assessment, (2) Design for Recovery, (3) Design for Multiple Use Cycles, (4) Circular Business Models, (5) Circular User Engagement, (6) Circular Economy Collaboration and (7) Circular Economy Communication (Wiek *et al.*, 2011). A summary of the competences' definitions and the concepts/methods related to competences developed by students were identified in the literature by Ploum *et al.* (2019): (a) *systems thinking competence*, as the ability to identify and analyse all relevant sub-systems across different domains (people, planet, profit) and disciplines, including their boundaries; (b) *foresighted thinking competence* as the ability to collectively analyse, evaluate and craft "pictures" of the future in which the impact of local and/or short-term decisions on environmental, social and economic issues is viewed on a global/cosmopolitan scale and in the long term (Wiek *et al.*, 2011); (c) *Regulatory competence*, as the ability to map, apply and reconcile sustainability values, principles and targets with internal and external stakeholders, without embracing any given norm but based on the good character of the one who is involved in sustainability issues (Barth *et al.*, 2007); (d) *action competence*, as the ability to actively involve oneself in responsible actions to improve the sustainability of social-ecological systems (Lans *et al.*, 2014); (e) *interpersonal competence*, as the ability to motivate, enable and facilitate collaborative and participatory sustainability activities and research; (f) *integrated problem-solving competence*, as the ability to structure relationships, spot issues and recognize the legitimacy of other viewpoints in business decision-making processes, whether environmental, social and/or economic issues. Table 1 summarized the competences and skills required for CE according to the recent literature.

2.3 Higher education programme in entrepreneurship education for circular economy

The literature affirmed the Universities' role in instilling entrepreneurial capabilities in students representing a good context for enhancing competence for creating new business venture universities; thus universities make unprecedented investments in their infrastructure for EE programmes (Matlay, 2011; Secundo *et al.*, 2020; Pittaway *et al.*, 2020; Toniolo *et al.*, 2020).

Despite the growing consensus on EE's role in the current turbulent scenarios as well as the transition toward a more sustainable society, developing higher education programmes for supporting the development of SE is considered to be low (Foucrier and Wiek, 2019). These programmes are the most consistent with the CE paradigm. Specifically, Moon's paper (2018) is devoted to the creation of new mind-sets for sustainable solutions.

To educate future sustainable entrepreneurs as "change agents" (Hesselbarth and Schaltegger, 2014) for sustainable development, specific competencies at individual levels are required. Competences are described as "enabling successful task performance and problem solving with respect to real-world problems, challenges, and/or opportunities on an individual level and consisting of knowledge elements, skills, and attitudes" (Ploum *et al.*, 2018). Many efforts are made to sustain SE such as new organizational forms that need new competences. These include employee-owned businesses and benefit corporations responding to prevalent challenges such as climate change, economic inequalities and unethical business behaviour (Jelonek and Urbaniec, 2019).

Analysing several papers related to competencies in education for sustainable development indicated a lack in University offerings for educating students with competencies in SE

Table 1.
The competences and
skills required for
Circular economy

Author	Competence	Competence's description
Wieck <i>et al.</i> (2011)	Anticipatory competences	Anticipatory analysis, evaluation and crafting of the future based on the lens of sustainability, efficiency and profitability
	Regulatory competences	The ability to collectively map, specify, apply, reconcile and negotiate sustainability values, principles, goals and targets [19] (p. 209)
	Strategic competences	Setting strategic goals for achieving sustainable growth through the orchestration of interventions, transitions and transformative governance strategies toward sustainability
	Interpersonal competences	Promoting collaboration and participatory decision-making by guaranteeing a plurality of views and promoting empathetic exchange of experiences
	Systems thinking competence	Identification and analysis of societal, environmental, economic sub-systems based on a cross-disciplinary framework
Ploum <i>et al.</i> (2019)	Foresighted thinking competence	Analysis and evaluation with a global and long term perspective on the impact of local and/or short-term decisions on environmental, social and economic issues
	Regulatory competence	Embracing good norms supporting the process of sustainable value creation by mapping, applying, and reconciling sustainability values, principles and targets with internal and external stakeholders
	Action competence	Active citizenship and ability to undertake responsible actions for the improving the sustainability of social-ecological systems
	Integrated problem-solving competence	Decision-making and evaluation of alternative scenarios by recognizing the legitimacy of other viewpoints in business decision-making processes
Foucrier and Wieck (2019)	System thinking	System perspective as a lens for evaluating and exploiting entrepreneurial opportunities emerging from the social, environmental and sustainability contexts
	Value thinking	Sustainability is the lens for the critical observation and evaluation of business opportunities and market trends
	Future thinking	Anticipatory analysis and foresight of the sustainability challenges, as well as of the economic, societal and environmental issues
	Interpersonal behaviours	Leverage on interpersonal network and social ties to recognize needs, anticipates trends and learn about opportunities

(continued)

Table 1.

Author	Competence	Competence's description
Sumter <i>et al.</i> (2020)	Circular impact assessment	Estimating the environmental impact of the circular offering on a system level over multiple use cycles to support decision-making during the design process
	Design for recovery	Incorporating recovery strategies during the design process while taking into account multiple use cycles
	Design for multiple use cycles	Foreseeing the consequences of prolonged use and multiple use cycles
	Circular business models	Concurrently developing the circular product, service and business model
	Circular user engagement	Engaging users in product use and (end-of-use) return
Dam <i>et al.</i> (2020)	Circular economy collaboration	Identifying, mapping, facilitating and managing the collaboration between external stakeholders in operationalizing a circular business model
	Circular economy communication	Telling consistent stories regarding circular offerings
	Collaboration, facilitation and negotiation skills in Industrial Design for CE	Competence for developing new designs and managing their life scenarios in a CE, which allow better collaboration with experts in circular business, production, distribution models and lifecycle thinking
	Practical expert knowledge in CE	Incorporating in industrial design education programmes, experimentation and action-based activities, with approaches such as open design or distributed production paradigms, on the sustainability field

(Vuorio *et al.*, 2018; Pittaway *et al.*, 2020), although considerable progress has been made by European HEIs in incorporating sustainable development (SD) in the curricula of higher education institutions (HEIs).

One reason for the shortage in educating students with SD competences is that, although a large number of researchers have developed diverse competency frameworks for SE, they are not applied to specific working contexts (Jelonek and Urbaniec, 2019). Foucrier and Wiek (2019, p. 2) defined in the current frameworks as “somewhat disconnected from the reality of entrepreneurship and/or lacking bridges across the different disciplines related to entrepreneurship.” Many authors have thus made an effort to contextualize more generic lists of competencies for SD in specific working contexts of change agents for sustainability. In this way, several scholars have identified and studied competencies for SD. These include: corporate social responsibility (CSR) managers, sustainable intrapreneurs, sustainable development champions and sustainable entrepreneurs (Ploum *et al.*, 2018).

Another reason for the lack is that the existing frameworks do not take into account the entrepreneurship process (from initial discovery through planning, start-up and build-out to consolidation and harvesting) with the different competencies required according to the process. “If graduates are to successfully start and run sustainability-oriented enterprises, the real-world entrepreneurship processes should provide the main orientation for training and learning” (Foucrier and Wiek, 2019, p. 2).

Recently, a study on the most relevant learning strategies for higher education programmes in sustainability (Tejedor *et al.*, 2018) identified some critical issues adopted in programmes for developing CE entrepreneurial development. Consistent with the literature on EE, such issues were identified as follows: problem-based, project oriented and service oriented learning, case studies and simulations. The combination of these different pedagogical approaches is needed to develop sustainable managerial competences, which allow students to benefit from different learning processes (Torres and Parini, 2019; Hägg and Gabrielsson, 2020). The learning approaches previously recalled and the competences defined need to be developed by a learning community of different stakeholders able to create learners’ awareness and capability to act in response to the environmental and social issues (Dembczyk and Zaoral, 2014; Cavallo *et al.*, 2018). Finally, a further distinctive element of sustainable entrepreneurship education is represented by the need to create technological know-how as technological knowledge supporting the identification of a market’s need for the conception of novel product and processes for entrepreneurship (Byers *et al.*, 2011; Romano *et al.*, 2014; Secundo *et al.*, 2015).

All this has motivated our research to provide an answer to the following research questions:

RQ2. How do Universities structure Entrepreneurship Education (EE) programmes for developing entrepreneurial competences and mindsets for Circular Economy (CE)?

3. Research method

The research questions are investigated through a critical cross-case comparison performed by adopting a web-based content analysis (McMillan, 2000) and interviews. As recognized in the literature, the web-based content analysis is an efficient method for collecting data from the web and it has been largely adopted for the investigation of trends associated to education (Navarro, 2008; Wu *et al.*, 2010; Ndou *et al.*, 2018).

The analysis sample is composed of 16 European higher education initiatives offered by Universities, Institutions and Entrepreneurship Centres, located in well-positioned regions ranking according to supranational observatories (i.e. Regional Innovation Scoreboard, Global Innovation Index). With reference to the geographical context analysed, it is important

to note that the issue of Circular Economy has received growing attention in the European area and that while in the more recent times several initiatives were promoted by the European Union for supporting the transition process toward the circular economy, the pillar of sustainability becomes a consolidated pillar of the Europe Union's strategic agenda since the conception in 2011 of the Horizon 2020 Strategy and the Smart Specialization Strategy.

Sample composition was chosen following criteria proposed in previous studies (Audretsch and Lehmann, 2005; Wright *et al.*, 2007; Guerrero and Urbano, 2012) specifically the Higher Education centres are:

- (1) born and rooted in entrepreneurial universities (Rasmussen and Sørheim, 2006; Eisenhardt and Graebner, 2007);
- (2) promoting an entrepreneurial culture by strategic actions;
- (3) focused on developing an entrepreneurial mindset for sustainable entrepreneurship even if in some cases they are purely business schools offering specialized programmes focused on different types of technologies;
- (4) offering diversified curricular and extracurricular initiatives for a wide target group of participants (University students, scientists, entrepreneurs etc.).
- (5) located in European countries.

The sample identification was performed through the use of the following terms “executive programme” and “circular economy,” “master” and “circular economy,” “education programme” and “circular economy,” “master” and “sustainable entrepreneurship,” “executive programme” and “sustainable entrepreneurship,” “sustainable entrepreneurship” and “educational programme.” Only the higher education initiatives at the European level and focused on entrepreneurship and/or business management in the context of CE were included. As McMillan (2000) proposes, after formulating the research questions and selecting the sample, the content analysis should continue with three other phases, consisting of the following phases:

Phase 1. Definition of categories for coding. To provide comparable cases for the entrepreneurship centres, we coded the variables and items to analyse. According to the literature, the main dimensions considered consist of: information regarding initiative and its proponents, target audience, learning objectives, entrepreneurship contents, learning pedagogies and stakeholders' engagement. The coding performed in this phase can be described as top-down (Park and Smith, 1989), since we defined topics of interest before the analysis started according to the theories of circular economy and entrepreneurship.

Phase 2. Collection of the contents for coding and checking the coding reliability. According to the analysis criteria previously identified, 16 initiatives were selected and analysed from October 2019–January 2020. With the aim to triangulate the findings and enhance the study reliability and validity, several data sources were used for gathering the information (Yin, 2013). Data sources were scanned according to a top-down coding approach, since researchers were driven by identification of the theoretical boundaries of the observed phenomenon to identify relevant topics related to the research objective (Park and Smith, 1989). Data collection and analysis are described in Table 2.

Phase 3. Analysis and interpretation of the data collected. To reveal relevant features characterizing the higher education training initiatives focused on CE, each source has been analysed through the use of a content analysis approach (McMillan, 2000).

Analysis of higher education training initiatives allowed identifying masters, doctorates and executive programmes in the European area. Since our objective is to identify emerging

Table 2.
Data Collection and
analysis

Data sources	Data analysis	Evidence collected
Web site	Contents and information from 10 websites of Universities and entrepreneurship centres were analysed in the period October 2019–January 2020	Information about type of courses (e.g. Ph.D., MSc, MBA etc.); organizer; country; duration; scheduling; faculty; target audience; learning approach; main contents (see Table 3 , first 3 columns)
Syllabus and Brochures	A total of 16 higher education programmes were extracted and their programmes and brochures were scrutinized to collect in-depth information	Information about type of courses (e.g. Ph.D., MSc, MBA etc.); organizer; country; duration; scheduling; faculty; target audience; learning approach; main contents (see Table 3 , final 2 columns and Figure 1)
News, press	News on the web were scrutinized to collect and identify new sources of data mainly regarding centre's mission and the learning initiatives	Evidence regarding learning programmes' mission and vision (see Table 3)
Interviews	YouTube and online interviews were scrutinized to obtain more insights on the centres' mission and strategies. The interviews of 4 directors of centres were analysed, and in the other cases we found 2 interviews of chairs and professors of the centres and 1 interview of past students	Insights regarding rationale behind the courses' design Perspective about learning contents, stakeholders' involvement See Figure 1

trends in EE for CE, our analysis has focused on initiatives related to topics as EE, business innovation, business model for CE. Accordingly, a research on the web was performed using the following keywords: “executive programme,” “master,” “education,” “innovation technology,” “circular economy,” “sustainable,” “business,” and “entrepreneurship.” Subsequently, research with key words was selected: “entrepreneurship,” “business” and “sustainable” in terms of circular economy. For each learning initiative, contents were coded adopting the mentioned categories and all data extracted were recorded in Excel files. The main aspects taken into consideration were: (a) Type of courses (e.g. Ph.D., MSc, MBA etc.); (b) Organizer; (c) Country; (d) Duration (week, months or years); (e) Scheduling (total hours, full time or week-end); (f) Faculty; (g) Target Audience; (h) Learning Approach; (i) Main Contents.

Data analysis was based on an in-depth cross-case analysis carried out through a graphic display. The results of data analysis were validated through interviews with the directors of the selected centres. Finally, data clustering was performed to derive the “common pillars” distinguishing the development of the entrepreneurial mindset for technology entrepreneurship. This has required the integration of top-down and bottom-up coding ([Park and Smith, 1989](#)), since, if in a top-down perspective, researchers were driven towards the investigation of specific issues of the observed phenomenon, in a deductive way compliant with the bottom-up approach, the learning programmes' analysis was performed with curiosity and openness useful to depict original insights.

4. Research findings

This section presents the results coming from the analysis of 16 higher education initiatives (masters, PhD courses, executive programmes) undertaken in European Universities, Institutions and Entrepreneurship Centres (see [Table 3](#)). All the learning programmes are characterized by common topics related to EE, business innovation, business model for CE; moreover, they provide tools and knowledge for supporting the transition of businesses and society from a linear to a circular economy configuration.

Table 3.
Cross cases
comparison of
education program
about circular economy
and sustainable
development

Education program name	Organizer	Country	Duration and Scheduling	Faculty	Target audience	Learning approach	Main contents
Coaching program C-BOOT	VITO Research Organization, Lund University, Trento University	Belgium, Sweden, Italy	3 Months – Full time	Hybrid	n. 18 interested in becoming entrepreneurs in the context of circular economy	Frontal lessons, on site visits to companies	Circular opportunity, principle of lean-start-up, how to pitch a circular business idea
MSc circular economy	LUT University	Finland	2 Years – Full time (120 ECTS)	Academic	Bachelor graduated students in technology science or engineering	Face-to-face contact instruction	Design for recovery and disassembly, sharing economy, biological and technical cycle in a CE
On-line course in engineering design for a circular economy	TU Delft University	Netherlands	6 weeks – Part-time (3/4 h per week)	Academic	Students and working professionals with a basic background knowledge of design, engineering and circular economy	On-line course available on platform	Design for R, strategic design to make better decisions

(continued)

Education program name	Organizer	Country	Duration and Scheduling	Faculty	Target audience	Learning approach	Main contents
International Master's Programme on circular economy	University of Graz, Chalmers University of Technology, Delft University of Technology, Leiden University, Norwegian University of Science and Technology	Austria, Sweden, Netherlands, Norway	2 Years - full-time (120 ECTS in 2 different host universities)	Academic	25 selected students with academic degree of at least 180 ECTS credits	Face-to-face contact instruction	University of Graz: The human dimension of circular economy Chalmers University: Climate change mitigation and sustainable energy systems in a circular economy Delft University/Leiden University: Design of circular economy Norwegian University: Modelling of circular economy
MBA in innovation, enterprise and circular economy	University of Bradford	United Kingdom	Flexible from 2 to 6 years – Part-time	Academic	Must have at least three years' postgraduate work experience, good first degree or a relevant professional qualification	Distance learning, self-study, online teaching and group discussions	Regenerative product design, new business model, materials-resources-energy and competitiveness, operations-marketing and strategic management
MSc technology innovation and management for a circular economy	Cranfield University	United Kingdom	2 years – Part-time	Academic	Students with degree and industrial experience	Face-to-face and online teaching	Managing the transition to a circular economy, circular manufacturing-design-value chain

(continued)

Table 3.

Table 3.

Education program name	Organizer	Country	Duration and Scheduling	Faculty	Target audience	Learning approach	Main contents
MSc. in Bioeconomy, circular economy and sustainable development	University of Piraeus, University of Athens	Greece	3 semesters – Full-time (90 ECTS)	Hybrid	Students	Face-to-face and traineeship in companies or organizations	Biosciences, circular economy and sustainable development, biological resource/product, business plan
Master in circular economy	Varna Free University	Bulgaria	2 or 3 semesters – part-time	Hybrid	Students and experts with professional interest in CE field	Interactive learning methods, summer schools and internships	Environmental policy, technological entrepreneurship, business model in CE
International Summer school in entrepreneurship and the circular economy	Glasgow Caledonian University (GCU)	Scotland	2 or 3 weeks course full-time and residential	Academic	Students who are currently, or have been, enrolled in an undergraduate degree programme	Interactive learning methods	Applying business skills to circular economy
Circular economy for business (executive course)	Sant’Anna, University of Pisa	Italy	20 days (8 h per day) - part-time (weekend)	Academic	25 participants, managers of companies and professionals, who collaborate with companies producing goods and services	Interactive methodologies and work groups	Circular economy management, circular economy design, green supply chain management for closing the loop, circular economy strategy development and business models, managing technologies supporting CE.

(continued)

Education program name	Organizer	Country	Duration and Scheduling	Faculty	Target audience	Learning approach	Main contents
Business sustainability and circular economy (executive course)	Bologna Business School	Italy	4 days - part-time	Hybrid	10–20 participants, people with not particular studies behind them but with a few years of work experience	Lectures, company testimonials, exercises and discussion of real cases	Measurement of sustainability (impact assessment and lifecycle assessment), circular economy mindsets, value loops and green manufacturing)
Executive Master in sustainability and business innovation	Bologna Business School	Italy	12 months - part-time (weekend formula)	Academic	Managers and employees involved in processes related to sustainability, circular economy and social innovation	International and interdisciplinary approach	General management, sustainability and business innovation
Business models for environmental sustainability (executive course)	Cuoa Business School	Italy	5 months - part-time	Hybrid	Entrepreneurs who have an interest in recognizing the relevance of the environment and the ecological issue	RBL - research based learning methodology	Sustainability and decision-making processes Public policies and choices for sustainability Measurement of sustainability
PhD Programme in innovation for the circular economy	Department of Economics and Statistics "Cognetti de Martiis", University of Turin	Italy	3 years - full-time	Hybrid	Graduates	Industrial doctoral program	Principles of circular economy Understanding innovation for the CE Developing solutions for the CE

(continued)

Table 3.

Table 3.

Education program name	Organizer	Country	Duration and Scheduling	Faculty	Target audience	Learning approach	Main contents
Executive Master in circular economy – management – Energy and waste management	Luiss Business School	Italy	12 months (1,500 h) -part-time (weekend formula)	Hybrid	Employees in environmental management	Meetings, seminars, workshops and other innovative teaching methodologies	Regulatory initial part, environmental innovation management, (specialization courses in waste management, energy management and smart mobility management)
Summer school CESARe (circular economy school in Apulia region)	University of Bari Aldo Moro	Italy	5 days - full-time	Academic	University students, graduates, PhD students, researchers, professionals and employees (max 40)	Lectures	General aspects of circular economy, (particular aspects analyzed: Sustainable finance, “end of waste” legislation and industrial symbiosis)

4.1 Highlights regarding sample composition

Regarding nature, the initiatives considered in our sample are largely represented by masters (8 on 16), executive programmes (7 on 16) and one PhD programme. More in detail, the offering of higher education included in our analysis about masters is populated by initiatives of MSc (Master of science), International programmes and executive ones. As for the executive programmes, they cover a large variety of initiatives shaping from an online course on design as in the Delft University to other specific issues related to the circular economy as well as to coaching programmes (i.e. VITO consortium). Only a PhD programme has been identified at the University of Turin (Italy).

Regarding organizers, the initiatives analysed are to a great extent promoted and managed by outstanding and well-ranked Universities, Entrepreneurship Centres and Business Schools, with the collaboration of associations of categories and institutions. An interesting evidence is regarding C-Boot executive programme that is organized by VITO (*Vlaamse Instelling voor Technologisch Onderzoek*) research organization in collaboration with Lund and Trento Universities.

As for the sample's geographical dimension, most of the initiatives identified are located in northern European countries, and mainly in Belgium, Sweden, Finland, UK, Netherlands and Norway. All of them are recognized as pioneer countries in CE policies and they all are well positioned according to the different innovation indexes performed by European and supranational observatories (i.e., Regional Innovation Scoreboard, Global Innovation Index). By focusing on southern Europe, Italy presents several initiatives included in. Among them, the only PhD programme included in the sample at the University of Turin, among several executive masters and programmes. Also in the case of Italy, the promoters of such initiatives are prestigious universities and business schools located in regions characterized by medium-high performance in terms of innovation and research and performing welfare policies (i.e. Trentino Alto Adige, Piemonte, Emilia-Romagna, Toscana). In the south of Italy, only one initiative was identified in the CESARe Summer School promoted by the University of Bari, in Puglia, that presents the profile of a moderate innovation according to the RIS (Regional Innovation Scoreboard). Regarding duration and scheduling, the initiatives of masters and PhD programmes are organized according to the standards required. Executive initiatives range from a period of three months (i.e. C-Boot), to 6 weeks (i.e. Online Course on Engineering Design), but there are also programmes of 20 days (Executive course at Sant'Anna of Pisa) and initiatives structured in 5 or 4 full days (i.e. CESARe at the University of Bari or the Business Sustainability and Circular Economy programme at the University of Bologna). Regarding *scheduling training*, programmes are organized as full-time and part-time, but there are also forms of distance learning (i.e. Online Executive on Engineering Design), residential ones (i.e. the International Summer School in Entrepreneurship and Circular Economy) and interesting initiatives in mobility between different universities (i.e. the International Master Programme on Circular Economy).

4.2 Faculty composition, target audience, learning contents and strategies for circular economy programme

4.2.1 Faculty composition. All the programmes allowed the participation of academic as well as professionals in their faculty. However, based on the analysis conducted on the educational programmes, it has been possible to identify in seven of them that the faculty is more characterized as hybrid while in the remaining the academic composition is prevalent. The participation of non-academic partners and professionals, managers and entrepreneurs, is recognized an element of distinctiveness for developing sustainable entrepreneurial competencies. This is the case of the MBA in Innovation, Enterprise and Circular Economy, promoted by the Bradford University, that see the collaboration of the Ellen

MacArthur Foundation, or the case of the Executive Master in Circular Economy Management Energy and Waste Management at LUISS, that is structured with the larger participations of managers from corporations operating in the field of energy and environment. A more academic and scientific faculty profile arises from the interview available for the Online Course in Engineering Design at Delft University, in which its faculty is described as follows: "Experts from leading European universities and research organizations will take you through the latest strategies in product design." Professors, researchers in different disciplines such as technology foresight, team building, innovation and sustainability, principle of CE, digital business, circular business model, start-up financing, project management and successful entrepreneurs or managers, institutions, local public authority, incubators, associations are directly engaged in the programmes.

The involvement of academic and non-academic partners in the EE programmes is a very important peculiarity that allows direct engagement by the actors involved in the entrepreneurial learning ecosystem to contribute to the local sustainable competitiveness by instilling EE capabilities in students and entrepreneurs or executives.

Target audience is largely differentiated. In all the cases, it is defined according to the criteria for the composition of classes in the different programmes with the only exception being the online course on Engineering Design (i.e. 18 in the C-Boot or 40 in CESARe). Regarding the participants' profile, a minimum number of credits is required for the university's students to assure the coverage of basic knowledge in the field of engineering, management, etc. Motivation and interest in the topics related to entrepreneurship and Circular Economy and an interest in recognizing the relevance of the environment and the ecological issue represent good points in the selection process.

In some cases, previous professional experiences are required. Several initiatives, mainly executive, are reserved for managers, entrepreneurs or potential entrepreneurs. The online interviews available have highlighted the importance for participants to have preliminary knowledge in the field of business management or technology management. Likewise, in some cases, mainly in the different Masters, previous working experiences allow better comprehending the meaning and benefits associated with the conception of CE business models as well as the transition's opportunities.

For the Online Engineering Design Course at Delft University, the target is defined as follows: *"This course is suitable for all learners who have an interest in product design, innovative engineering, new business activity, entrepreneurship, sustainability, circular economy, and everyone who thinks the current way we do things in the world needs a radical rethink."*

In other courses, the audience is largely defined without any specific criteria as in the case of C-Boot Programme: *"I would recommend this programme to other people like me because sometimes it's difficult to envision business models which are different from the traditional ones. So, it's a way of experimenting, also, get some knowledge from guys which come from sustainability and other things"* (Coach at C-Boot Vito Programme). The executive master in Circular Economy Management at LUISS University focuses on people interested in circular economy as *"... a new way of setting up production processes but it is also a new way of thinking regarding products; to conceive the product, this will therefore have a strong impact on traditional productions and of course it has already opened and always will open new types of production to new types of services"* (a Professor and Faculty Member).

4.2.2 Learning approaches. Regarding the learning approach, all programmes provide great integration of face-to-face lessons, seminars, on-site visits to companies, working groups and project works and internships. Following the EE learning approaches, the initiatives analysed integrate the traditional seminars with experiential and hands-on practical learning approaches such as business plan competition, based on simulation, project work, traineeship in companies, workshop and distance learning methodology. Modules

online and forms of distance learning are also well-practiced in several initiatives, such as in the Online Course in Engineering Design, the MBA in Innovation, Enterprise and Circular Economy, the MSc Technology Innovation and Management for a Circular Economy, the International Summer School in Entrepreneurship and the Circular Economy, etc. The interviews allowed to understand as the higher education initiatives included in the sample are characterized by the practice of learning in action strategies, addressed towards project works, practical sessions, competitions, gaming sessions. Specifically, the learning approach at C-Boot Vito Programme is defined by a coach of the VITO Institute of Technology research as follows: *"I joined this programme to travel, to meet new people and to discover new ways of approaching the circular field. I wanted to learn more about entrepreneurship and how to become an entrepreneur. A very valuable learning, both for the participants but also for us as coaches. I think, one of the real particularities is that, you know, by working together, they can really test business ideas."*

The innovative learning approaches allow the development both soft and technological skills in the area of digital economy, circular economy and managerial/entrepreneurial methodologies, such as business planning, business canvas and project management.

4.2.3 Learning contents. As for the contents, the different initiatives cover a large spectrum of thematic areas by integrating topics related to entrepreneurship, business management, technology management, human resources management, engineering, legal frameworks and ethics with the topics of circular economy. Regarding entrepreneurship education and business management, meaningful attention is reserved to the principles of lean start-ups and elevator pitch (as in the C-Boot), business plan (as in MSc in Bioeconomy, Circular Economy and Sustainable Development), the fundamentals of technological entrepreneurship and circular business models. About business management, the main topics are related to the sharing economy (as in the MSc Circular Economy), operations marketing and strategic management (as in the MBA in Innovation, Enterprise and Circular Economy), business skills for circular economy, innovation for circular economy, management of the transition from a linear to a circular economy and green supply chain. This is the case of the MSc Circular Economy LUT University, in which a Professor describes the programme: *"...This programme itself connects different aspects of our lives like energy, waste, material and mobility, but also ways of thinking, sharing economy, how to make new business models. Circular economy is a key thing in making sustainable business in the future."*

As for CE, this thematic area is prominent in all the programmes even if the different initiatives present a specific focus on some dimensions of the paradigm. The most common issue is represented by the design for CE that is presented in almost all the programmes, even defined in different terms, such as design for recovery and disassembly (i.e. MSc Circular Economy), design for better decision-making (i.e. online course in Engineering Design), regenerative product design (i.e. MBA in Innovation, Enterprise and Circular Economy), circular economy design (i.e. Circular Economy for business – executive course). A specific focus on designing arises from the interview available for Online Course in Engineering Design at Delft University as follows: *"...You will learn innovative ways in which companies are creating value, while securing their supply chain by integrating design for R. The design of product forms an important part of the concept of a circular economy." The circular economy approach aims to help in addressing material challenges by keeping materials in use much longer. The principle is that waste must be minimized. Products will be designed to last longer. They will be easier to reuse, repair, remanufacture. All the parts in the products will eventually be broken down and recycled. This is the design for R which we will exploit."*

Other specific issues of the circular economy can be identified in modules related to climate change mitigation and sustainable energy systems (i.e. one of the programmes included in the International Master programme on Circular Economy), biosciences and biological resources/product (i.e. MSc in Bioeconomy, Circular Economy and Sustainable Development),

Environmental policy (i.e. Master in Circular Economy), human resource management and circular mindsets (i.e. Business Sustainability and Circular Economy – executive course or one of the programmes associated to the International Master on Circular Economy), technology management for the circular economy (i.e. Circular Economy for Business – executive programme), public policies and regulations for sustainability and industrial symbiosis (i.e. Business models for environmental sustainability – executive programme and the Executive master in Circular Economy Management, Energy and Waste management). Specific industry issues can be identified in the manufacturing, energy and environment, waste, mobility. The need of creating profiles able to combine competencies in entrepreneurship, business management engineering and technological is common in almost all the programmes analysed. This is aimed to satisfy the need of innovative profiles of human capital that as declared by Danilo Bonato, member of the faculty of the Executive Master in Circular Economy Management at LUISS declares: *“vertical experts on a topic are no longer needed but the circular economy by its nature requires a broad systemic vision of the innovation of change; therefore the recommendation to truly invest in a range of skills, knowledge and experience that are not limited to one field specific sector but concern the fundamental themes of the economics of social sciences and clearly also of technology which is an essential element to then implement solutions oriented to the circular economy.”*

Furthermore, all the programmes converge on the need for creating awareness regarding the real meaning of CE that, as declared by the Scientific Coordinator of the CeSARE Summer School, is *“not just a question of transforming waste, but creating new business models. We must not be afraid of new frontiers of industrial organization and new technologies.”*

Interdisciplinary work among the faculty, the participant and the contents represents an opportunity to acquire different competences in a different way.

By considering specific and common issues, four main thematic clusters can be identified from the learning programmes available on the websites and online interviews, such as: (1) circular economy business model, with a focus on sustainable value proposition and value drivers, KPIs, value creation, capture and transfer, sustainable human resource management and CSR; (2) green supply chain management, with a focus on circular manufacturing-design-value chain and design for R products, reuse, repair, remanufacturing and recycle, industrial symbiosis and waste management; (3) technology entrepreneurship and innovation, with a focus on green technologies, key enabling technologies and technology exploration and disruptive innovation; (4) public policies and institutional frameworks, with a focus on sustainable development goals, national and supranational traits and laws.

A summary of the overall empirical evidence allows providing a framework according to the main components above analysed: the rationale and learning objectives (why); the contents (what), the students target and the stakeholders (who), the learning processes (how) (Figure 1).

5. Discussions

In confirming EE's relevance at European level (Ndou *et al.*, 2018; Miranda *et al.*, 2020; Secundo *et al.*, 2020), findings provide elements for proposing innovative way to create competence in the CE field from an entrepreneurship perspective as well as for derive a major understanding of the way through which Universities structure their entrepreneurial education programs for CE. Our evidence highlights that the competences and skills needed for the CE paradigm are in line with the technology intensive entrepreneurial process typical of the entrepreneurial venture incumbents and start-ups (Byers *et al.*, 2011).

The analysis of the cases offers evidence in terms of knowledge and competencies supporting young students, post-graduate students, start-up owners and entrepreneurs in their work of change agents, consistent with the CE principles (Hesselbarth and Schaltegger, 2014;

Bergset, 2018; Jelonek and Urbaniec, 2019); this is consistent with the strategic role covered by education and training for developing sustainable business models and behaviours (Nibbi *et al.*, 2019). Contextualized in terms of real problems, industrial contexts and technological know-how for practical implementation by entrepreneurs and start-up operators, the evidence collected demonstrates that it is possible to overcome the risk of disconnection associated with education from a sustainable perspective (Foucrier and Wiek, 2019; Jelonek and Urbaniec, 2019). This is confirmed by the great attention reserved to several learning modules related to technologies' aspects.

Findings demonstrated that the programmes initiatives analysed in the study are in line with the recommendations and suggestions of supranational organizations, such as the European Commission, and international associations such as the Ellen MacArthur Foundation in the CE field. Specifically, the first European Circular Economy Action Plan (2015) and new European Circular Economy Action Plan (2020), as one of the building blocks of Green Deal (EGD) (2020), aim to sustain the EU's transition to a circular economy by reducing pressure on natural resources and will create sustainable growth and jobs. The plans present an ambitious strategic and operational planning programme to stimulate Europe's transition to the CE, strengthening its competitiveness on a global scale, promoting sustainable economic growth paths and better conditions of work and social well-being. The development of specific learning programmes in the CE field represents an important instrument to follow the EU recommendations. Moreover, the recent recommendations provided by the Ellen MacArthur Foundation (2021) stressed the need to incorporate CE in school and higher education curricula by developing training programmes and apprenticeships.

Investments in programmes that increase skills in the CE field allow creating economies based on the new opportunities and support an inclusive transition to a CE. This transition allows the creation of new jobs in this sector, such as design and production, maintenance and repairs, that require investment in new programmes to sustain the development of technological, digital and manual skills. Focusing on the large spectrum of programmes identified, covering different types of educational patterns including short and executive courses, masters and PhD programmes as well as their different targets, it is possible to understand that sustainability and CE are topics of growing interest in the different types of EE programmes.

As for the contents, all programmes analysed present elements of great coherence with the main thematic pillars of EE grounded in the domain of CE and sustainability.

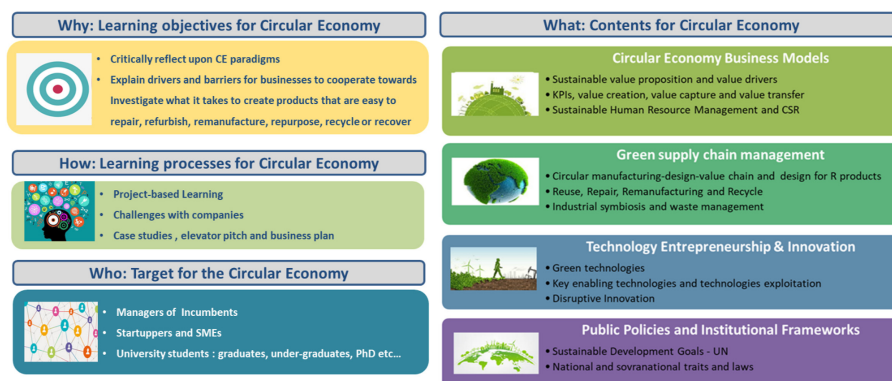


Figure 1.
Multidimensional
framework for circular
economy
entrepreneurship
education programmes

As suggested by the literature on EE and CE, the design of education programme needs to embrace more project-based activities and experimental approaches which can support the uptake of circular economy practices (Pittaway *et al.*, 2020; Secundo *et al.*, 2020).

Specifically, all programmes adopted new entrepreneurial education approaches, typical of EE; that is, action-based or project based, which are fundamental to acquire the entrepreneurial mindset, confirming the relevant EE literature. This requires the stakeholders' direct involvement in the local ecosystem, such as innovative companies, institution, associations of categories, banks and others in sustaining entrepreneurial development competences in the context of CE. Universities, Institutions and Entrepreneurship Centres represent a fertile context to develop entrepreneurial competences in CE in students, managers, executives, entrepreneurs or potential entrepreneurs by offering training initiatives (Matlay, 2011; Secundo *et al.*, 2020; Toniolo *et al.*, 2020).

Innovative entrepreneurs in the CE field or companies share their entrepreneurial knowledge and experiences in the education programme classes enabling the development of action-based knowledge required to start a new venture by following the principle of CE. Despite the different programme target, the analysis underlined that participants with prior knowledge and competence in business or technology are facilitated in acquiring the in-depth skills offered by the programmes and in the identification of business opportunities coming from the application of CE principles and approaches.

Open innovation challenges that companies launch to identify the innovative solution developed by students represent another important key success element of the entrepreneurial programmes as well as the participation of non-academic partners for development of sustainable entrepreneurial competencies.

However, some specific trends can be identified, and it is possible to note that the sample is largely characterized by a business and managerial orientation. Only in a few cases, the technological perspective more consistent with the perspective of technological entrepreneurship (Secundo *et al.*, 2015) arises, in terms of designing, waste management, manufacturing and energy technologies. Interdisciplinary work among the faculty, the participant and the contents, that range from entrepreneurship, sustainability, business management, key enabling technologies, represents an opportunity to acquire different competences in a different way from traditional courses allowing the acquisition of different capabilities.

Another interesting consideration emerging from the analysis of the cases is related to the profiles and the geographical location of the institutions proposing the educational patterns. Almost all the cases are, indeed, related to organizations operating in regions well-ranked and positioned in the main indexes and reports of EU observatories, such as Regional Innovation Scoreboard or Eco-Innovation Scoreboard. Specifically, almost all the initiatives are located in regional and national context characterized by strong innovation performance and advanced policies for the entrepreneurial development (Romano *et al.*, 2014; Rodil-Marzábal and Vence-Deza, 2020). It is the case of the northern European countries included, represented by universities and business schools in Belgium, Sweden, Finland, UK, Netherlands, Norway as well as by Italian regions in which universities and business schools are also located. All of them are characterized by medium-high performance in terms of innovation and research and performing welfare policies (i.e. Trentino Alto Adige, Piemonte, Emilia-Romagna, Toscana). In the meantime, the geographical map depicted by this research confirms the European trends related to higher education and entrepreneurship education with interesting updating on the emerging focus on sustainability and CE (OECD, 2008; Fayolle, 2018).

In this perspective, the universities and business schools identified present a profile consistent with the archetype of entrepreneurial universities (Secundo *et al.*, 2015), regarding their EE programmes, teaching methods and the hybrid faculty including a large community

of stakeholders. For this purpose, the focus on the issue of sustainability and CE suggests areas for future investigation related to the circular configuration of universities and their specialization in educational initiatives supporting creation of qualified human capital with entrepreneurial skills and competencies but also in terms of new organizational settings for entrepreneurial universities on the principles of the circular economy (Mendoza *et al.*, 2019; Salguero-Puerta *et al.*, 2019).

6. Conclusions, implications and future research

The analysis of the education initiatives has allowed understanding which are the main trends in the field of EE and CE at European level. This suggests new insights and implications for the agenda of scholars and researchers in such promising fields. The number of educational programmes identified, the outstanding profile of education institutions that are offering them and mainly the thematic areas included in the programmes allow deriving a positive judgement regarding CE implications from the entrepreneurship perspective and their deeper connection for sustainable value development (Foucrier and Wiek, 2019; Fyen *et al.*, 2019). Entrepreneurship is, indeed, the enabling process supporting the implementation of the CE paradigm and this is made possible by focusing on the creation of suitable competencies and skills in human capital (Frishammar and Parida, 2019).

6.1 Implications for theory

This paper aims to contribute to the nascent body of literature on teaching the CE in higher education institutions from the EE Perspective. Regarding learning approaches adopted, almost all the cases are characterized by pedagogical approaches and methods resulting from entrepreneurship education, such as experiential learning, project-based learning, case studies, project work, elevator pitch and business plan development. All these approaches are proposed for guiding learners into the exploration of specific issues in the domain of CE and to allow acquiring awareness and critical thinking (Torres and Parini, 2019). A further element of evidence regards major involvement of professionals and entrepreneurs in the faculties, the public-private collaborations supporting the programmes or the joint design and organization made by different universities in the same initiative. This is consistent with one of the main relevant principles of entrepreneurship education that sees the process of learning resulting from learners' interaction in a community of stakeholders (Cantino *et al.*, 2017; Ndou *et al.*, 2018).

As a learning environment populated by a community of different stakeholders able to create in the learners the awareness and capability to act in response to the environmental and social issues (Dembczyk and Zaoral, 2014; Romano *et al.*, 2014; Cavallo *et al.*, 2018), these entrepreneurship programmes are suitable contexts for supporting the creation of entrepreneurial skills, competencies and capabilities also in the CE domain. All these are likely needed not only for proper start-up and/or business owners, but also for managers, designers, project managers engaged in entrepreneurial organizations facing circular economy transitions. In addition, policy-makers and people working in institutions are also likely to play a key role in the entrepreneurship-driven transition to circular economy models providing ad hoc guidelines, supports and financing of novel programmes to create and entrepreneurial mindset in the field of Circular Economy.

6.2 Implications for practices

The study also allows deriving some final remarks regarding essential role of educational initiatives in affording the challenges associated to the transition from a linear to a circular economy paradigm. By focusing on the more common and poorly-disseminated thematic areas included in the programmes analysed, some insights arise for developing future

learning initiatives that could be to addressed towards the achievement of educational objectives related to: (1) rethinking in a circular, sustainable and innovative way the process of creating value in the incumbents, (2) exploring the meaning and benefits of collaborative approaches and participation in circular economy innovation ecosystems; (3) developing advanced models for soft-skills development, in terms of leadership, ethics and motivational and creative skills. For the goals of this study, this latter is the most relevant one.

All these elements offer a deeper understanding of the processes and dynamics related to entrepreneurship education in the light of the CE by shedding new light on this still unexplored and under-researched domain. The evidence collected in terms of initiatives, contents and approaches represents an original contribution and can form a valuable basis for future studies.

The Multidimensional Framework for Circular Economy presented in this study and its components could be useful for entrepreneurs who want to start the transition of their linear economy models to CE, by offering guidelines to follow in this process. Moreover, the analysis indicates that the programme targets are not only students with a prior knowledge in business or technology, but also entrepreneurs and executives or manager that could improve their capabilities to start a business transformation in a circular and sustainable perspectives.

6.3 Limitations and future research

In the meantime, authors are aware of the limitations of this research. These are mainly due to the qualitative nature of the study conducted, sources for data collection and sample considered. For the future development of this research, the authors hope to overcome such limitations by widening the basis of evidence with quantitative evidence, to be collected through surveys and questionnaires addressed to participants and organizers in the different educational initiatives and by focusing the attention on a larger and differentiated sample that could include other geographical contexts and allow deriving common and distinctive factors. Another important limitation of this study refers to the research context focused on the European Universities and Research Centres, which leaves out interesting experiences carried out in the rest of the world, especially in the USA, where the Ellen MacArthur Foundation is involved in developing and promoting CE around the world by sensitizing business, academia, policymakers and institutions.

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