The role of higher education towards sustainable consumption behavioural change: topics discussed in sustainable consumption education

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***Abstract*— Many factors have contributed to the urgency of adopting sustainable consumption patterns. The main challenges related to sustainable consumption include respecting our planet in all its complexity and diversity, taking care of communities and life and, to this end, adopting consumption and production patterns that protect human rights and the well-being of communities. The theme of education for sustainable consumption is multidisciplinary with elements from different curriculum topics and addresses all aspects of everyday life. Establishing a common understanding of sustainable consumption education will create a shared understanding of the topic and improve the necessary cooperation between educators and students, making sustainable consumption education an established and more understandable topic. The objective of this study is to identify the main topics within sustainable consumption education teaching and learning, the main barriers and propose some actions that contribute to a sustainable behavioural change in higher education. A literature review was carried out to categorize the main topics related to teaching and learning processes in higher education environments to fill the gap in this underrepresented research topic of education for sustainable consumption. The review allowed the collection of information reported in this new millennium and the identification, selection and critical evaluation of research related to education for sustainable consumption.**

Keywords*— *Sustainable consumption, Higher education, Consumer behaviour, Consumption education

I. Introduction

Several factors have led to the urgent need of actions to change Sustainable Consumption (SC) patterns. Environmental degradation, which is driven primarily by the rise of population, by their consumption habits, and technology, has reached such a level that there is no more time to waste and urgent action is required. The main challenges related to SC include respect for our planet in all its complexity and diversity, caring for communities and life, and to that end adopting new lifestyles and production patterns that safeguard human rights and the well-being of communities. Furthermore, to safeguard the earth's regenerative capacities and to guarantee that economic activities in all its forms support human progress in a fair and sustainable way.

Sustainable development as well as Sustainable Production (SP) and consumption are complex concepts to define in a continuously changing society. The roots of Sustainable Consumption Education (SCE) lie in the education for environmental issues with the United Nation Conference on the Human Environment that was held in 1972 [1] and was the base to the creation of the United Nations Environmental Program (UNEP) and to the International Environmental Education Program (IEEP) with the Belgrade Charter in 1975, the Global Framework for Environmental Education [2]. Sustainable Development (SD) is a concept that started to gain visibility after 1987 with the report published by the Brundtland Commission regarding "Our Common Future". Dissemination in Higher Education Institutions (HEIs) took its time and at the beginning of the new millennium, many HEIs were still starting to introduce it into their systems. Furthermore, the generation of knowledge related to how to move to a more global sustainable world has been much more intense on issues related to the SP of goods and services than on issues related to SC.

The United Nations Economic Commission for Europe (UNECE) assumed a plan for Education for Sustainable Development (ESD), which was meant to inspire the members of UNECE to build and integrate ESD into their formal and informal education practices, for all pertinent subjects. Ten years later the UNECE plan for ESD presented the assessment report on the execution of the plan from 2005 to 2015. In this report most of the initiatives taken were focused on primary and secondary education. The way that SCE approaches are implemented in the universities will have an impact on the behaviour and on the way that SC will be perceived in the future and so it is essential to better understand the various approaches to integrate the SCE in Higher Education (HE). Education for a SC and production can be trained as an interdisciplinary topic and/or integrated into projects or mainstreamed as a topic of an existing discipline articulated by others. The topic of SCE is multidisciplinary with elements from different topics of the curriculum and deals with all aspects of everyday life. Being a holistic topic, it needs to create an integrated approach that reflects the various facets of peoples´ daily actions. Establishing a widespread awareness of education for a more SC, will create a shared understanding of the topic and improve the necessary cooperation among educators and learners making the SCE an established and more understandable topic. There is however a need to foster research related to how to teach SC.

The goal of this work is to recognize the crucial pedagogical approaches that are being used by HEIs, the main faced barriers and envisage practical implications of the pedagogical approaches to support the learning for SC in HE. HE towards SC cannot be anticipated to totally change the community's consumption patterns, but education may have

an important role towards the SC behavioural change. HE can play a significant role and contribute to the process of changing students' behaviours contributing to building the power of next generations to overcome the challenges of nowadays non SC practices. However, educating for SC in HEIs is still incipient and poorly developed and there are still few contributions helping to bridge that gap. HE should, however, equip the students with the knowledge and skills necessary so they can better understand how their consumption patterns may be considered a key driver of the environmental and social change.

This work is a literature review performed to categorize the main topics related to the teaching and learning processes in HE environments to overcome the gap of this underrepresented research topic of SCE. Section II of the paper is devoted to the SC debate followed by Section III where the topic of SCE is clarified with the evolution since the early 90s of the last century. The literature review concerns the evolution observed in the new millennium and is presented in Section IV along with the research questions and the methodology. The contribution towards a SC behavioural change in higher education is presented in Section V and lastly the conclusions in Section VI.

II. The Sustainable Consumption Debate

International policy on consumer affairs is a reality that dates back to the 70s of the last century. SC entered the political discourse in the 1990s with the Rio Earth Summit [3]. Chapter 4 of the Agenda 21 covered two programme areas (i.e., focus on non SC and non SP patterns; the development of national policies and plans to boost changes in non SC patterns). After RIO 92 conference, a huge range of institutional programs related to SC began to take place. The Oslo Symposium in 1994 projected a definition to SC that is related with the utilization of tangible products as well as services answering to elementary needs and delivering an improved quality of life. The main objective is to do that while diminishing the utilization of natural resources, pollutant substances and emissions of waste taking into care the whole life cycle, so as not to make vulnerable the needs of next generations [4].

In the World Summit on SD in 2002 (WSSD), SC was discussed in the Johannesburg Plan of Implementation [5] and recognised, along with SP and the protection and management of the natural resources, the foundation of economic and social growth. Those were essential requirements for SD and for the established key objectives. At the United Nations Conference on SD (Rio+20), the world's Heads of States embraced the 10-Year Framework of Programmes on SC and SP (10YFP) [6]. The framework of programmes (10YFP) encouraged the enhancement of international cooperation to achieve more mutual impact of the shift to SC and SP.

In May 2012 the European Commission (EC) presented the Consumer Agenda representing a new consumer policy strategy as an initiative to approach the consumer interests highlighting the most relevant consumer concerns [7]. In December 2015, the Paris Agreement was convened with the goal of keeping the global temperature rise well below 2ºC and thus requiring international cooperation to reduce global greenhouse gas emissions [8]. The consumers are key and may have a vital role in reducing greenhouse gas emissions by making more environmentally conscious choices. It is vital to empower consumers, and education plays a critical role so that consumers can make sustainable choices. However, it is important draw attention to the fact that customer information and education should not put the responsibility on the consumers to find the best offers and protecting themselves against unfair practices, as this should be assured.

In 2015, the 2030 Agenda for SD was established with the 17 Sustainable Development Goals (SDGs). The SDG 12 represents responsible SC and SP aiming to contribute considerably to poverty relief and to the shift on the road to low-carbon strategies and greener economies. The goal is to uncouple economic progress from environmental problems and maximizing resource efficiency while supporting sustainable everyday life [9]. In November 2020 the EC initiated the New Consumer Agenda where it was presented the vision of the European Union (EU) consumer policy from 2020 to 2025 with the pursuit of empowering consumers to turn out to be the driver of change. The European individuals have a very important role as consumers in the change that globally needs to occur. Their actions are of vital importance reason why consumers should be empowered to change consumption habits not forgetting to assure that their rights are safeguarded. The new Agenda presents actions that will foster the SC practices to a green world considering that consumer habits go beyond frontiers of the individual Member States [10].

III. Education for Sustainable Consumption

One of the statements made at the RIO 92 when SC and production was acknowledged refers that a huge reason for the environmental decline and for the problems specially in the more industrialized countries is related to unsustainable behaviours of production as well as consumption. This situation is very concerning and contributed to the societal imbalances and for the poverty increasing pattern. Education can play a huge role in offering individuals with the necessary skills to increase the SC behaviours.

Ten years after the Earth Summit that occurred in Rio in 1992, the United Nations Educational, Scientific and Cultural Organization (UNESCO) prepared a report in its position as task supervisor for chapter 36 of Agenda 21 on education, awareness, and training. UNESCO referred that the Education is in fact a crucial issue for ethical and environmental perception achievement along with attitudes and behaviours that are coherent with SC and SP so that more educated citizens can have a strong participation in public decisions contributing to the sustainable development [11]. The Marrakech process that was launched in 2003 was devoted to the developing of the 10-Year Framework of Programmes on SC and SP (10YFP) with a total of seven task forces with one task dedicated to SCE [12] where recommendations and guidelines for SCE were produced to guide educators and policy makers on how to integrate SCE in formal education [13].

UNESCO has assigned 2005-2014 as the ten years span of Education for SD, to which the Organisation for Economic Co-operation and Development (OECD) contributed by emphasizing good practices in educational curricula for SD with Italy leading the Marrakech Task Force on SCE, to produce instructions and applied exercises for SC at the distinct stages of education [14].

Some countries implemented education plans as part of their SC scheme as for example Czech Republic or Finland where the SC plan involves advocating sustainable education

as a main target. Other projects as the UK action plan "I Will if You Will" or the Swedish "Think Twice" contains educational elements for encouraging sustainable household consumption. Many countries also invested in the growth of "Eco-Schools" where the schools adopted environmental methodologies in several areas involving curricula, buildings, management of waste, resources, and energy efficiency. The Eco-Schools programme was established in 1994 to address SD at local level and there are a growing number of schools taking part in the Eco-School network predominantly in Europe but also in other continents as Africa for example [15].

A good practice example in the European Union is the project "Persuasive Power of Children Towards Energy Consumption" [16]. Some valuable policy documents underline the demand for an instructive answer, describing education as a very effective tool for giving citizens with the right skills to change the SC way of acting [14]. UNESCO as the expert agency for education is the coordinator of the Education 2030 Agenda that implies the global commitment of the Education for All movement.

Education is key to attain the 17 SDGs where goal 4 is devoted to guarantee inclusion and education with high equitable quality for all, as well as lifelong educational opportunities [17]. Education, in fact, can be one of the crucial topics for the accomplishment of SD. However, education that encourages economic progress alone may be controversial and may also be responsible for the growth of non SC patterns. It is very important to empower individuals to take advised decisions and accountable actions for environmental truthfulness, economic feasibility and a fair society for the present and for the next generations [17].

The European Higher Education Area ministers signed the Rome Communiqué in November 2020 [18] and are determined to assists HEIs to take part of the society to address the several risks to global peace, representative values, autonomy of information, health issues, and not least those that came up with the pandemic of COVID 19. The HEIs should be able to prepare learners to be consumer conscious and be able to develop solutions to better prepare students for the challenges related to SC: respect the planet and life and its diversity, transition to a more resilient economy and society, safeguarding the wellbeing and the human social rights as well as the planet resources, always assuring SC and SP.

IV. Literature Review

The main objective of this section is the presentation of a comprehensive state of the art regarding SC discussed within HE to develop understanding regarding the extent and evolution of SC research issues within HE in science, technology, and engineering, over the past twenty years and classify the main topics related to the teaching and learning processes in HE settings to better understand the gap of this underrepresented research topic of SCE.

The main goal of the study is related with the need to foster research linked to SC educational issues, identify the main barriers and envisage some actions to contribute towards a sustainable behavioural change in HE. One of the challenges of the review was to focus on the specific subject of SCE since there are several research works including literature reviews that in a more comprehensive way deal with sustainability and SD in HE (e.g. [19]–[24]). Additionally, [25] special volume includes 13 papers that clarify some of the attempts made by HEIs to contribute to sustainability. As the collection of papers illustrates, many efforts were made in the implementation of sustainability strategies and SD in HE settings; however, there are still many challenges to integrate the SDGs and SD into their approaches, and so many chances exist for investigation in the topic.

Also a bibliometric analysis concerning the University Social Responsibility was made [26] for the period 1970-2019 accounting for 870 articles and evidence shown a rising worldwide attention on the impacts of University Social Responsibility. The same authors [26] also refer that future investigation should focus on analysing the relationships between the Social Responsibility and SC of HEIs. In addition, it is worth mentioning that SC and more specifically the topic of SCE need more attention in HEIs and globally in science, engineering, and technology settings.

A. Literature Review Methodology

The literature review will provide researchers with guidance and insight into the problem. The methodology is comprised of five steps (Fig. 1) and starts with the presentation of the research questions that are the essential elements that guide the entire review methodology highlighting the type of information that is required and enlightening the search and selection of relevant studies guiding and orienting the subsequent analysis. The formulated research questions are:

a) What is the evolution of SCE in science and technology in HE in the new millennium?

b) What are the main topics within teaching and learning SC issues in HE setting?

c) What are the major barriers to the implementation of SC practices and approaches in HE?

d) How the literature review findings can contribute towards SC behavioral change in HE?

The literature review begins (Step 1) with the definition of the research questions that guide the study. The location of the studies (Step 2) covers the searches to be made by the selection of the databases, all the search strings to be used, the keywords as well as search conventions.

The location of the research works was put up with search strings in electronic databases to identify the publications that were appropriate to the extent of the review. The bibliometric assessment was performed on the broadly common Web of Science (WoS) that make available the examination in quite a few electronic databases with cross-disciplinary investigation, letting in-depth exploration of topics including science, social

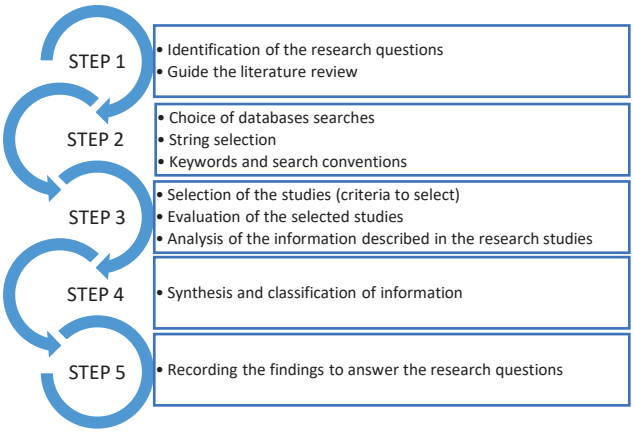

Fig. 1. Literature review Steps

science, arts, humanities (i.e., supporting 256 disciplines). All WoS classes were data searched to perform the selection. The selected studies belong to this new millennium and so the research before 2000 was not taken into consideration since it was considered that this would not have a major impact on the study to be carried out. The search criteria included papers, paper proceedings, review papers and early access documents, not including records that did not conform to these conditions. The search strings were chosen to contain terms associated with SC and terms related to science, technology, and engineering education.

The next step (Step 3) of the review methodology is related to the selection and assessment of the significant studies according to the selection criteria and based on the previously defined search strings, keywords, and search criteria. The search strings used consisted of a combination of keywords, truncation symbols, and boolean operators that entered the search box of the WoS. In the search the field tag topic was used, and the strings combination were mainly "sustainable consum*" and "engineering education" and, science or technology. A total of 91 records were chosen for further analysis. After the selection and analysis of the studies the next step is related to the synthesis and classification of the information (Step 4) whose main objective consists in developing the knowledge regarding the magnitude and evolution of SCE investigation topics throughout the new millennium. Lastly (Step 5) the stating of the findings and reorganization of the relevant information into distinct settings throughout the examination of the investigation content to be able to answer the main research questions.

B. Analysis and Synthesis

The selected works were examined and grouped by the publication year. The evolution is presented in Fig. 2 where it is possible to see that the number of publications increased considerably from 2016 till the present with the greatest number of works published in 2021 corresponding to a total of 20.9% of the published work from 2000 till 2021. The number of works published in 2019 corresponds to a total of 17.6% and a total of 13.6% of records in the year of 2016. The increasing number of publications from 2016 till 2021was something to be expected to be in accordance with some remarkable events that occurred in 2015.

The analysis of the type of documents allows to conclude that 83% corresponds to articles, 12.1% corresponds to proceeding papers, 3.3% correspond to review papers, with data papers and early access corresponding to the remaining published work. Also, the main categories were identified with a total of 48.4% of the research belonging to Green Sustainable Science, Technology, 41.8% of the research studies belonging to the category of environmental sciences, 23.1% fitting environmental engineering and with 23.1% of the category environmental studies. A total of 15.4% of the studies are for education and educational research, and 12.1% belongs to economics, 5.5% of the business category, 4.4% from energy fuels, 4.4% of regional urban planning, 3.3% of food science technology as well as 3.3% from the category nutrition and dietetics.

The abstracts of the 91 selected works were analysed and the works that not directly contributed to the research questions and were not able to directly impact on the topic under study were discarded. Some papers whose subject is centred on the academic curricula were mainly related to research activities and outreach activities linked to circular

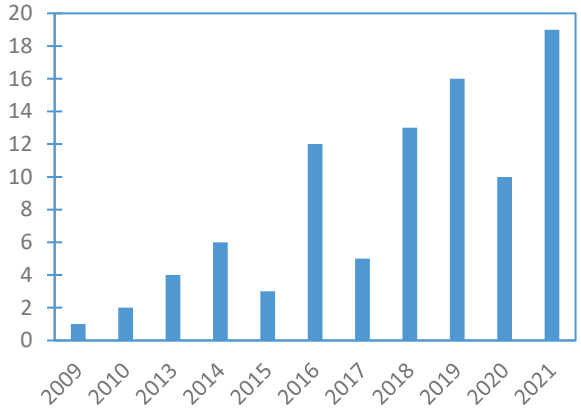

Fig. 2. Total Number of Publications by year

economy and circular economy thinking and related to sustainable campus management but not directly to SCE. Another type of works despite being related to SC did not focus on the subject of higher education, but on business decision making and on insights to support choices made by managers and industry practitioners. Some other studies were related with changes to go towards sustainable production and responsible consumption and on how to ensure SC but without focusing on the educational issues. Additional type of studies that were rejected were related to green consumers ´choices regarding purchase of food products. Articles addressing how changes occurring in the environment affect consumer behaviour were also excluded because they did not comply with the research questions. Some other discarded studies were related to organizational marketing environment and how firm competences affect the implementation of SC. Some works despite being related with higher education teaching and learning were not directly related to consumption, but with a more global issue as SD and a lot of works were associated with sustainability projects for learning initiatives. Some articles address theories, concepts, methods and approaches related to HE for SD such as stakeholder engagement, campus operations, sustainability assessment, reporting and organizational shift management but do not give emphasis to educational issues related to SC.

The main reasons used to make the screening of this research works were centred on the impact that they could make to better understanding the topics discussed in SCE with the goal of knowing the evolution of SCE in science, technology and engineering. Furthermore, the selected studies made possible a better understanding of the main topics within the teaching and learning of SC in HE as well as the main barriers faced by institutions in the implementation of SC practices with the with the aim of gaining a more in-depth knowledge of how the review findings can contribute to the SC behavioural change in HE settings.

C. Identification of the Main Topics to Teaching and Learning

SCE is a multidisciplinary subject reason why the identification of key issues is a difficult task due to the rapidly changing technological, economic, and social conditions where new technical and scientific innovations as well as political and social circumstances are continuously changing.

SC deals with the way in which each person interacts with the society and with the environment and calls for education

settings that can incorporate learning as broad as possible. HE for SC is essential in providing learners with suitable information on the impact of their day-to-day choices as consumers. The identification of the main topics within teaching and learning SC in HE was made, and the main topics emerged as depicted in Table 1. The first topic identified is related to SC competencies, learning objectives and curricula development. Guidelines for learning outcomes and generic competences of education in SC were established in 2010 by UNEP [13]. However, Frank [27] in contrast to the established competency framework gave emphasis to the significance of emotional and motivational learning outcomes. The author pointed out the understanding, the emotional resilience, self-care, development of ethical attributes and mindset for sustainability. According to Frank [27] and to address those issues future research should through empirical observation substantiate and operationalize individual skills and prominent tools for the assessment of those abilities.

Centred on the evaluation tools, pedagogical formats ought to be elaborated and evaluated to see the potential to stimulate individual SC competencies. Strydom & Kempen [28] highlighted how HE can influence skills specific training through a case study at a business incubation hub. Valor and co-workers [29] examined the moral competencies and offered a thorough conceptual and a measurable systematization of moral aptitudes that are crucial to the field of SCE. Frank et al. [30] explored the connection between introspection and key abilities for SC and they investigated whether mindfulness instruction can cultivate the capability to introspect and stimulate the development of key competences for SC. Gombert-Courvoisier et al. [31] based on case report identified five pedagogic issues that seem crucial in training learners to deal with real-life complex challenges and showed how those issues could contribute to expanding the students´ key competencies.

Another very important topic is related with SC assessment in HE institutions. Longoria et al. [32] presented a co-creation model with a interdisciplinary methodology, seeking to deal with global needs with tools for the development of new or modified products and/or services to assist the transition of consumers in the direction of a more responsible consumption. The model for HE enables to gain knowledge and insights of the community profiles to after conform with the terms of SDG 12: responsible production and consumption. Margaça et al. [33] developed an assessment instrument, the SC scale which can promote the evaluation and prediction concerning a SC attitude.

The prediction of the SC behaviour is another topic and some authors used psycho-behavioural sciences to explain human behaviour [34]–[36]. Also face to face interviews and descriptive survey methods were used to better understand the students SC behaviour in specific circumstances [37], [38].

Dimante et al. [41] found that involving learners in awareness-raising through a self-audit and system thinking contributed to students changing behaviour with real changes in consumption. Alvarez-Suárez et al. [43] study demonstrated the chances of an educational policy that when employed to trainee teachers in HE promotes SC. Zsoka et al. [44] used multidimensional scaling method and were able to identify consistencies and inconsistencies in behaviour in order to promote the creation of more effective educational instruments for supporting SC. Motivations to SC are so multifaceted that seeking for robust and valuable issues to refer regarding consumer motivation is frequently (as well as for behaviours) a case of considering up a range of works from different types of perception and instituting broad understandings of the topic [46], [47]. Also, understanding SC behaviour is crucial to better understand how to encourage initiatives that stimulate students' recognition of the crucial role that they play in creating a society and on how to inspire students to choose sustainable and conscientious lifestyles.

TABLE I. RESULTS OF THE LITERATURE RESEARCH RELATED WITH THE TOPICS

Topic	Type of study	Ref.
SC competencies Learning objectives Curricula development	Conceptual model	[27]
	Case study design	[28]
	Self-report questionnaire	[29]
	Exploratory study	[30]
	Focused mindfulness training	[30]
	Case report	[31] [39]
SC assessment	Conceptual model	[32]
	SC scale development and validation	[33]
	Survey research	[40]
Factors that predict SC behaviour Behavioural domain of energy/water literacy Values Motivation Consumption practices	Theory of planned behaviour (TPB)	[34] [35]
	Psychological theory that links beliefs to behaviour	[29]
	Face-to-face survey	[37]
	Descriptive survey method, system thinking	[38]
	Survey design	[41]
	Teaching strategy intervention	[42]
	Multidimensional scaling methodology	[43]
	Student-led exercise	[44]
	Case study	[45]
	Survey research	[46]
	Quantitative method	[47]
Pedagogical approaches for education Learning settings for students Knowledge co-creation process Development of training materials Action-oriented to SC Learner-centred to SC Transformative approaches teaching to SC	Teaching-learning strategies problem-based learning (PBL), project-oriented learning (POL), cross-disciplinary workshops.	[48]
	Literature review	[49]
	Project based seminars	[50]
	Living labs- experiments in a real-world setting	[51]
	Case Study	[52]
	Literature Review	[53]
Institutional barriers Design education Barriers Role of university	Literature Review	[54]
	Projects with experimental case studies	[55]
	Case study	[56]
	Green public procurement initiatives	[57]
	Exploratory study	[58]
	Project based seminars	[50]

Other valuable topic is related with pedagogical approaches for SC education and learning settings for students. Reference [48] used active learning approaches (i.e. problem based learning, project oriented learning and cross disciplinary workshops) to understand their impact as pedagogical tools in the acquisition of competences for sustainability and also in the change in consumption habits. The conclusions of the study showed that the active learning strategies implemented in the curriculum were beneficial for the acquisition of SC competencies. Barth et al. [50] analysed the main issues of a teaching method to fostering learning for SC in HE with a series of project-based seminars and explained how the integration of trans disciplinarity can help to sustain rich and deep learning settings for students.

D. Barriers to the Implementation of Sustainable Consumption Practices and Approaches in Higher Education?

Engineering and Technology Education is being reshaped on how to prepare learners for life: for new careers; for the challenges of a fast-transforming society; and with a special emphasis on preparing learners for the rapid technological changes. From the literature review, we could conclude that some issues related to SCE are being addressed, but there is a lack of cohesion and innovative processes.

Kemper et al. [54] refer some institutional barriers that sometimes persist within universities, business schools, and the marketing discipline. The barriers were identified as impacting the capability to make 'bottom-up' change. The authors claim that institutions, as well as disciplines stay committed to beliefs involving the compatibility among the environmental and economic progress and recognition of market powers and so the growth of alternative viewpoints on sustainability and SC continues highly challenging.

Küçüksayraç et al. [56] explores the mediator role of HEIs in expanding design for sustainability (which is a crucial part of SC and production) into the industry. It might be a challenge to ensure that the knowledge flows among the education, investigation, and outreach actions over planned activities. The number of scholars that possess the necessary abilities and expertise to carry out outreach actions is at a low level, even at a low level in the sustainability or SC field. The university culture and resistance to change may be a strong barrier to HEIs due to the complexity and sometimes great slowness of the decision-making process in discussions on curriculum redesign. Another barrier is the still reduced social interaction between HEIs and all the stakeholders. It is imperative to improve the interactions of the HEIs with all the stakeholders maximizing the mutual learning and innovative framework.

Barth et al. [50] refer that conceptually approaches to SCE in universities are still poorly developed. The authors show in what way the incorporation of the notion of trans disciplinarity can assist to additional usage of SCE and provide for meaningful learning settings for learners. They also refer the need for more research and to empirically study its capacity for encouraging learning processes.

Küçüksayraç et al. [56] also refer the need to assess the circumstantial factors cautiously before initial outreach actions for shaping the opportunity, aim and stakeholders and also the need to carefully guarantee the awareness of flow among the education, investigation and outreach actions through flexible planned activities.

The literature review also found examples of teacher education to address SD and SC in the Higher Schools of Education around the world with the main objective to reorient instructor education to address sustainability mostly in universities of education that train teachers to work at the level of basic and secondary education. However, university professors at science, engineering and technology schools at universities also need to address SC topics and universities have to determine which subjects to highlight within their curricula, courses, practices, and strategies.

The main objective should be to ensure that science, technology, and engineering programs tailored the environmental, social, and economic circumstances and goals of their neighbourhoods, regions, and countries and that HE may have a determining role towards SC behavioural change of the society.

Reshaping the curriculum is a challenge in engineering schools, mainly because sometimes the argument is related to an overcrowded curriculum where the argument to have a flexible engineering curriculum is always the fear that faculty have in leaving something out [39]. The issue of sustainability is sometimes also perceived as irrelevant by academic staff when compared with other technical issues [59] and this will delay the systemic change in HEIs in the direction of sustainability and delay the incorporation of SC and production issues in HEIs curricula. Some academics may be difficult to convince because they may perceive SC issues as irrelevant to their disciplines, and sustainability issues in a more broadening way [60]. Issues related to very compartmentalized education systems can become a barrier and discourage the interdisciplinary cooperation among instructors [61].

Veiga e Ávila et al. [58] performed an exploratory study on barriers in universities to better understand what at present inhibits universities from becoming involved in SD efforts. The study concluded that literacy concerning SD and SC as well as the shortage of knowledge management to link science, technology and SD is a challenge. Changes also need to keep occurring in teaching and learning practices with the use of new methodologies able of encouraging learners' attention and stimulate their autonomy and critical thinking vital for the current and upcoming demands. Learners must handle their own emotional responses to the SC issues and motivating students to have a more SC behaviour is far from simple since personal behaviours are profoundly embedded in social and institutional settings reason why education is a key to change people's attitudes.

Fig. 3 presents the main identified barriers that may inhibit the implementation of SC practices in HEIs.

The institutional drive and commitment of HEIs can also be an important barrier if university governing bodies fail to adopt policies and fail to implement actions to address SC and more broadly the SDGs. Universities cannot fail the objective of building a culture for responsible consumption and production.

V. Contribution Towards A Sustainable Consumption Behavioral Change In Higher Education

Behavioural change is pivotal to ensure SC and production and a more sustainable future. HE for SC demands that individuals will gain the expertise, information, and abilities on the environmental and social consequences of their day-to-

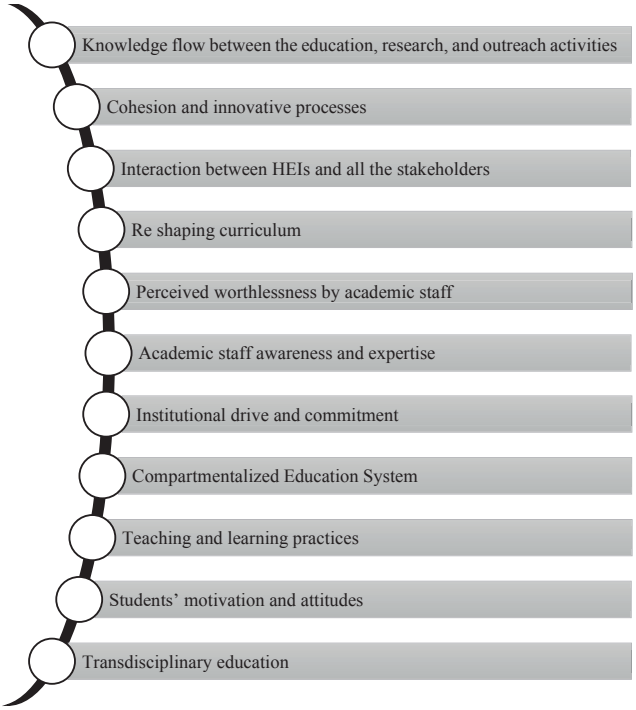

Fig. 3. Main identified barriers that debilitate the implementation of SC practices in HEIs.

day options. The SCE will also contribute to assist students in taking part in the economy and public discussion and grow into players of change towards more SC behaviours. Adding to this HE for SC is also meant to allow students to take accountable decisions and behaviours. Pimdee [36] classified and compared opinions from student teachers from diverse university teaching programs that can help educational leaders to develop programs that help to change sustainable consumer behaviour, but also the design of actions related to faculty professional development as those student teachers are the influencers of future´s leaders. Merritt et al. [46] showed that students report greater use of SC procedures at the end of a course intended to address answers related to enhancing human health and wellbeing whilst decreasing the misuse of natural resources. Actions related to curriculum/course development that address SC will empower individuals to be responsible consumers. Segalas et al. [52] describes a project whose goal is to stimulate SC and SP of products and services in Europe. The project is based on co-creation processes and training materials through open education resources. The utilization of online teaching materials for students training as well as faculty training programs will empower individuals SC literacy. Knowledge co-creation and innovation requires institutional commitment and partnership development. The authors also refer the importance of a continuous professional development. Programmes related to SC embedded in continuous professional development will be very beneficial for teachers and a central mechanism to transform teaching and learning setting.

Gombert-Courvoisier et al. [31] advocate the need of some pedagogical principles to SCE that seem essential in training students basing on a social ecology guidance with production and consumption system, inspiring collaborative learning from the diversity of learners and tackling the complexity by an interdisciplinary methodology. The required interdisciplinarity would benefit with academics with different scientific background collaborating in courses re-shaping.

Valor et al. [29] developed an instrument to aid educators for sustainable consumption establishing moral competences as learning objectives. The study may contribute to the development of SCE curricula. Larner et al. [62] made use of living labs in a food choice specific experiment that involved staging tests in a real-world situation. They were able to carefully monitor and evaluate the experiments and concluded that this could be an exciting and friendly study system to foster widespread sustainable food selection. Other studies investigate if mindfulness instruction can enrich the power to introspect and inspire the development of SC practices [30]. Also, projects can be very helpful with experiential learning based on pedagogic case studies where learners suggest useful designs with a sustainable methodology [55]. Design for sustainability is a key part of SC and SP and HEIs have an intermediary position in spreading sustainability by design into industry and outreach activities along with educational actions and investigation, through which learning is used in solving difficult societal problems [56]. Margaça et al. [33] refer that HEIs have shown a larger concern for expanding the range of sustainable policies and programs, both in curricula and in the development and conversion of infrastructures, to support SC and performed in-depth investigation on SC and responsible behaviours.

Based on the review, we envisaged some actions that can contribute to sustainable behavioural change in HE settings:

a) Actions related to curriculum/course development

- *Online courses in SC and production (the HEIs due to the COVID-19 pandemic were forced to adjust online classes and are now more prepared to develop and minister online courses).*
- *Introduce SC topics into projects, dissertations, and curricular internships.*
- *Interdisciplinarity and academic collaboration in courses reshaping.*
- *Workshops/seminars regarding SC in science, technology, and engineering education.*

b) Actions related to Institutional Commitment

- *HE Deans and board of directors should demonstrate leadership and commitment regarding the SC topic.*
- *Leadership must ensure that the SC and sustainable production is included in the policy and objectives of the institution and that the SC actions are being integrated into the HEIs processes.*
- *Establish campus operations based upon SC and sustainable production.*
- *Establish sustainable partnerships with stakeholders.*
- *Promotion and outreach SC activities.*

c) Actions related to faculty Professional development

- *Faculty exchanges interfaculty related to SC and sustainable production.*
- *Faculty training in SC and sustainable production.*

- *Cultivate instructor SC education projects to interact with community to increase SC personal literacy.*
- *Faculty training programs on pedagogical approaches to SC with broad principles and methods of education used in teaching practice.*

VI. Conclusions

SCE is a vital piece of education for SD. The procedure of reorientating instructors coaching to focus on sustainability is a remarkable question facing HEIs. The inclusion of training in SCE is similarly crucial in face of the lack of focus on sustainability issues related with consumer attitudes and behaviour. Also, the need for increased instructors coaching and the continuously changing content of SCE contributes to the complexity. To avoid turn into a subject that is not able to motivate HE learners, teacher training for SCE needs to reinforce global, upcoming-oriented, and helpful perspectives. It requires to point out the consideration of students to current alternate consumption models and lifestyles. SCE should offer students appropriate guidance that they can use during the course of their professions and routines.

SCE requires collaboration between disciplines and transdisciplinary education where not only collaboration takes place between the distinct disciplines but also with the involvement of others, such as the problem owners, the community, the users, and so on which means that it is necessary to go beyond the disciplines. Transdisciplinary education may suffer from some institutional cultural as well as structural impediments. Evans [63] highlight some significant questions that are somehow familiar to those faced in interdisciplinary relationships. Some examples are for instance the sharp separation between disciplines such as mathematics, sciences and engineering and the social sciences or humanities on the other hand. Another issue is the increasing specialization within the disciplines and the silo structures that fractures the knowledge along disciplinary lines.

HEIs need to address SC through the curriculum in an integrated way. One strong handicap is sometimes the university culture and resistance to change and the high level of debates on curriculum re-design built on the curriculum as a instrument of authority in the HEIs culture.

The review came to show that some good examples exist, but it is difficult to bring together theory and practice and sometimes relate the contents to the day to day lives of the students. The curriculum as a means to develop the students´ intellectual SC capacity is fundamental to prepare students for the future life and the teaching and learning strategies will play a central role to the learning effectiveness. In the context of SCE curriculum, its main activities will be focused on the teaching and learning practices of SC. The education for SC will have a central role for the achievement of SC practices and the curriculum development highlight areas of action for SCE.

There is a strong interrelation between production and consumption as depicted in SDG 12 but there is still a strong orientation for production aspects that are somehow easy to identify, quantify and monitor and communicate with some mandatory instruments as for example energy labels, deposit refunding systems or recovery quotas among others [64]. However a gap of understanding regarding SC remains an issue and there is still a strong need for the increasing recognition from customers related to better products, services and clear information. Reference [65] highlights some of the knowledge gained from changing a narrow approach to the industrial-driven circular economy and introducing consumer behaviour as a key factor. SCE requires the integration of key SC issues into teaching and learning and more embracing sustainability issues. However, some difficulties may also arise because sometimes the SC education tends to focus on the implementation of programs that despite being locally relevant, enchanting the local social, economic, and eco-friendly conditions may fail when it comes to seeing the topic in a more global and systemic way. Another issue is related to the pedagogical approaches for SCE and the role of the instructor in the institution and the process of reorienting the instructor training to address the topics related to SC, which is a challenging process for many HEIs. Participatory teaching and learning methods will be very helpful to empower and motivate students in order to change their SC behaviours with experiential learning with emphasis on group or student-led learning. The use of real-world case studies and systems analysis as well as project-based learning will stimulate system thinking and analysis. Also, the utilization of role play and the creativity to envision future scenarios as well as discussion groups and critical reflection are among the pedagogical approaches required to shift towards a more participatory, experiential and active learning methods engaging students and making real difference in their understanding, and behaviour through SC practices, and ability to act.

HEIs can have substantial impact on the social, economic, and environmental wellbeing within their campuses, regions and globally. Leadership and HEIs commitment regarding SC are vital and universities acting responsibility can make significant contributions to SC achievement. HEIs awareness and support are fundamental for reorienting teacher education to address SCE.

HEIs are the leading institutions for the spreading of knowledge, through teaching, and for the generation of new knowledge, through research reason why the HEIs are essential players in achieving the SDGs where achieving SC and production will deliver SDG 12 embodying SC and SP but also contributing meaningfully to the achievement of almost all the remaining SDGs directly or indirectly. The sustainable production and SC can be reinforced by the targets in SDG 4 and SDG 8 that link education and economic progress respectively to the achievement of SP and SC.

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