

Please cite the Published Version

Corrêa, Matheus, Lima, Brenno Vinicius de Medeiros, Martins, Vitor William Batista, Rampasso, Izabela Simon, Anholon, Rosley, Quelhas, Osvaldo LG and Leal Filho, Walter (D) (2020) An analysis of the insertion of sustainability elements in undergraduate design courses offered by Brazilian higher education institutions: an exploratory study. Journal of Cleaner Production, 272. 122733 ISSN 0959-6526

DOI: https://doi.org/10.1016/j.jclepro.2020.122733

Publisher: Elsevier BV

Version: Accepted Version

Downloaded from: https://e-space.mmu.ac.uk/626214/

Usage rights: Creative Commons: Attribution-Noncommercial-No Derivative Works 4.0

Additional Information: This is an author accepted manuscript of a paper accepted for publication in Journal of Cleaner Production, published by and copyright Elsevier.

Enquiries:

If you have questions about this document, contact openresearch@mmu.ac.uk. Please include the URL of the record in e-space. If you believe that your, or a third party's rights have been compromised through this document please see our Take Down policy (available from https://www.mmu.ac.uk/library/using-the-library/policies-and-guidelines)

An Analysis of the Insertion of Sustainability Elements in Undergraduate Design courses offered by Brazilian Higher Education Institutions: an exploratory study Journal of Cleaner Production 272:122733 Article number 122733 Nov 2020, https://www.sciencedirect.com/science/article/abs/pii/S0959652620327803?via%3Dihub Abstract

When it comes to the perception of sustainability in all of its aspects, Higher Education 10 Institutions (HEIs) worldwide are responsible for preparing students, changing their attitudes, 11 and encouraging them to think about future generations. In this sense, the main objective of 12 this study is to analyze how sustainability has been inserted in undergraduate design courses 13 offered by Brazilian HEIs. For this study, 30 pedagogic projects of the aforementioned courses 14 were analyzed through a content analysis technique. The results demonstrated that the analyzed 15 design undergraduate courses are still at an early stage of considering guidelines that take 16 17 sustainability into account. The most critical point is the small number of laboratories and research groups dedicated to this subject, as well as the small number of academic events and 18 extension programs associated with this subject. The discussions presented here can greatly 19 20 contribute to and enhance the debate about improvements in design courses in the context of sustainability. 21

22

23 Keywords: Sustainability; Sustainable Development, Design courses, Transdisciplinarity.

24

25 **1. Introduction**

26

The challenges imposed on society regarding negative environmental impacts, a scarcity of resources and increasing inequalities will require a change in professional training standards to align them with sustainability guidelines. In this context, the concept of sustainability is wide-ranging (Barata et al., 2014; Camioto et al., 2017; Cozendey da Silva et al., 2018; Martins et al., 2019b; I.S. Rampasso et al., 2019), but it generally focuses on the idea disseminated by the World Commission on Environment and Development (WCEED), that states that "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987, p.16).

Similarly, in 2015, the United Nations (UN) provided an important contribution to the 36 search for a more sustainable future through the proposition of the 17 Sustainable Development 37 Goals (SDGs), in which 169 targets were presented to be reached until 2030 (D'Amato et al., 38 2019; V. Martins et al., 2019b; Pohlmann et al., 2019; Sales Moreira, 2018). When focusing 39 40 specifically on goals SDG #9 and #12, it is possible to identify the relevance of designers for these goals. This is because these professionals are characterized by performing innovative 41 42 actions, infrastructure improvements, and improving incentives to sustainable consumption and production. The ninth goal highlights the need to establish industrialization according to 43 sustainable guidelines, emphasizing the use of clean technologies in order to make them 44 positively contribute to economic growth, job creation and an efficient use of natural resources. 45 The efficient use and management of natural resources are also mentioned by goal SDG #12, 46 in which the importance of seeking sustainable standards not only in production, but also in 47 consumption is emphasized (UN, 2017). 48

In addition to these goals, the fourth goal of the 17 SDGs focuses specifically on quality 49 education. Among the targets considered within this SDG, education for sustainable 50 51 development can be highlighted as an important driver of a sustainable future (I. S. Rampasso et al., 2019; UN, 2017; UNESCO, 2017). The literature has also emphasized the key role 52 53 performed by HEIs in the search for a sustainable future (Benkari, 2013; Boarin et al., 2019; 54 Hoover and Harder, 2015; Sassen et al., 2018; Stephens et al., 2008). In this sense, HEIs 55 worldwide are increasingly responsible for making students aware of themes regarding sustainability, in order to present a focus on an economic growth that also considers social and 56 57 environmental aspects (Alves et al., 2015; Hamid et al., 2017; Ramísio et al., 2019; Rampasso 58 et al., 2018).

59 To achieve this, a significant training of undergraduate students is required. In recent years, the integration of sustainable development in higher education has been receiving 60 growing attention (Verhulst and Van Doorsselaer, 2015). This training needs to go further in 61 technical training, and must emphasize critical thinking, as well as multidisciplinarity, 62 transdisciplinarity and others skills (Barba-Sánchez and Atienza-Sahuquillo, 2018; Fan and 63 Yu, 2017; Garbie, 2017; Rampasso et al., 2018; Zeiny, 2012). However, according to Tejedor 64 et al., (2018) there is a long path ahead. These authors argue that in order to train undergraduate 65 students on aspects related to sustainability, it is necessary to identify and discuss the 66 relationship of relevant social problems with the integration of knowledge in the learning 67

processes, thus providing socially robust results that are transferable to practice. Therefore, 68 transdisciplinary approaches can not only be associated with the promotion of a more 69 continuous and critical reasoning, but can also contribute to teachers overcoming 70 monodisciplinarity. In this sense, there will be several challenges faced by HEIs when 71 72 restructuring their undergraduate course curricula. Proper planning and a constancy of purpose may enable HEIs to obtain satisfactory results that contribute to a better future (Leal Filho et 73 74 al., 2019; I. S. Rampasso et al., 2019).

When specifically analyzing the designer profession, it is possible to note that it performs 75 76 an important role in the creation and evolution of the built environment (Mustapha et al., 2013). Therefore, it can greatly contribute to sustainable development (Nunes, 2017; Zeiny, 2012). In 77 this regard, HEIs that offer undergraduate design courses should structure their curricula 78 around aspects of ethics and environmental, social and economic development (O'Flaherty and 79 Liddy, 2018; Schneiderman and Freihoefer, 2012). 80

Given this context presented and the importance of the Brazilian economy, it is 81 interesting to draw an overview for how Brazilian HEIs are inserting sustainability in their 82 undergraduate design courses. To do this, this research evaluates the pedagogical projects of 83 84 undergraduate Design courses from 30 different higher education institutions, in order to better 85 understand this reality. This context was considered in this paper due to the lack of studies related to the teaching of sustainability in undergraduate courses (Disterheft et al., 2015). 86 87 According to this gap in the literature, the results presented here can greatly contribute to the enhancement of these debates. Moreover, the training of design professionals in sustainability 88 89 has gained considerable attention recently (Boehm and Kopec, 2016).

In addition to this introductory section, this article is structured into four more sections. 90 91 Section 2 is dedicated to the theoretical framework that served as the foundation for this study's logic. Section 3 addresses the methodological procedures that were developed. Section 4 92 93 presents the results and the discussion for this study, considering the literature about the theme. Section 5 sets out the conclusions and proposals for future studies. 94

- 95
- 2. Theoretical background 96

97

This section presents concepts and debates about critical thinking, transdisciplinarity in 98 99 higher education, teaching for sustainable development and, finally, the importance of the designer in the search for a better future. 100

According to Meyer et al. (2017), sustainability is an area of knowledge that provides different insights to reflect and address real-life needs. In the current context, sustainability is essential due to the challenges experienced by society in the 21st century. These challenges will only be overcome through disciplinary and institutional integration (Anderson et al., 2015; Kirby, 2019; Remington-Doucette et al., 2013).

Biberhofer and Rammel (2017) reinforce the importance of sustainable teaching, 106 highlighting the need of a transdisciplinary scenario between science and society, aiming to 107 develop concrete professional competences aligned with the interests of humanity. Proitz and 108 109 Wittek (2019) and Schneider et al. (2019) corroborate this view by arguing that transdisciplinarity should serve as a guide to enhance the resolution of real problems. Guerra 110 (2017) conceptualizes transdisciplinarity in higher education as the use of a holistic approach 111 that goes beyond the limits of the areas of knowledge, allowing and facilitating the total 112 integration of different concepts through the interaction of people from different areas. 113

114 The role of HEIs is to train professionals to be capable of managing economically and socially sustainable productive activities and, furthermore, to develop an education with strong 115 116 values to promote a fairer society (Novo-Corti et al., 2018; Rodríguez-Solera and Silva-Laya, 2017; Sinakou et al., 2018). Franco et al. (2019) emphasize that education has been impacted 117 118 and strongly shaped by the influence of the global sustainability agenda, highlighting that many HEIs are focused on the formation of future leaders who act towards the goals of sustainable 119 120 development. In fact, it is always possible to notice a positive correlation; as companies are under pressure from society to comply with sustainable guidelines, HEIs need to shape 121 122 themselves to qualify a new type of professional, characterized by proactive thinking regarding the use of sustainable elements in the development of their work. Increasingly, these 123 institutions must offer courses that focus not only on normative profit goals, but also on social 124 and environmental competencies. That is, it is important that they are able to promote 125 professional performance by prioritizing and focusing on sustainable development (Hoveskog 126 et al., 2018; Remington-Doucette et al., 2013; Souleles, 2017). 127

Leal Filho et al. (Leal Filho et al., 2019) highlight that the insertion of sustainability in higher education is an important goal for HEIs, however, it demands proper planning. Rampasso et al. (Rampasso et al., 2018) developed a study in which they demonstrated how the difficulties associated with the inclusion of sustainability in engineering education are related, in particular considering the difficulties associated with structure and planning and difficulties observed in didactic practice. Additionally, Rampasso et al. (I. S. Rampasso et al., 2019) developed another study in which they aimed to consider a sample of Brazilian students' perceptions in order to analyze the challenges to insert sustainability into engineering courses. According to their findings, the most evident challenges were: a) sustainable issues were debated only in specific disciplines to a limited extent; b) it is difficult to integrate disciplines for the broad teaching of sustainability; c) there is a lack of practical and real examples of how sustainability can be embedded in the specific context of the course, and; d) the activities and examples presented focused exclusively on environmental issues.

More specifically, it is worth highlighting the designer as a professional who can greatly 141 contribute to sustainable development. Wagner et al. (2019) highlight the growing concern of 142 143 consumers about environmentally sustainable products, thus demonstrating the importance of professionals who consider environmental and social implications at all stages of a product's 144 lifecycle. In this regard, there are tools to support ecological design throughout a product's 145 lifecycle, such as the EcoDesign Strategy Wheel, Life Cycle Design Strategies, spider-web, 146 and Okala impact factors. These tools aim to minimize the negative environmental impacts of 147 148 products (Doğan et al., 2016). Hurney et al. (2016) argue that students that have subjects related to sustainability tend to have a greater engagement in their professional actions. Despite the 149 150 importance of these subjects for the training of design professionals, there are institutions that do not provide them for their students. 151

152 Nevertheless, Hur and Cassidy (2019) show that there is still a lack of consensus and knowledge about the guidelines for sustainable design. Focusing on fashion design, these 153 154 authors emphasize the potential for designers to reduce the social and environmental negative impacts of the apparel production process and consumption patterns. However, both internal 155 156 and external challenges need to be overcome for this to occur. Among the internal challenges, there is a need for a proper understanding of sustainable design and a consensus regarding this 157 concept. There is also a difficulty in reconciling a sustainable design with other demands (i.e. 158 costs, trends and product appearance). The complexity level of sustainability subjects is an 159 160 external challenge, as is the lack of demand driven by sustainable issues and a lack of incentives and/or recognition for companies to be sustainable. Sustainability concerns for the fashion 161 162 industry are especially important since it is among the most polluting industries in the world (DeLong et al., 2016). 163

Vezzani and Gonzaga (2017) demonstrated through an action research the importance of design professionals in the development of social sustainability projects. The aim of the study was to understand and reflect on how to define an educational model that was capable of preparing future designers to act actively and entrepreneurially towards sustainable goals. The authors pointed out that it is necessary to encourage young people to think about sustainability not only in the context of present challenges, but also considering future needs. Specifically,
however, it is emphasized that social sustainability is still a largely neglected area in the training
of these professionals.

Takala and Korhonem-Yrjanheikki (Takala and Korhonen-Yrjänheikki, 2019) highlight major challenges faced by HEIs when it comes to training designers. These authors argue that the education system was designed to train professionals in specific subjects, in contrast with the transdisciplinary character of sustainability. Ueda (Ueda, 2018) also corroborates this argument. To minimize this issue, Gatti et al. (2019) propose the use of alternative education approaches through active methodologies, such as action and experimental learning by using the simulation game technique.

According to O'Rafferty et al. (2014) the difficulty of teaching design students in a transdisciplinary manner is especially relevant when real-world problems are considered, such as, for example, shortages of raw materials, environmental impacts and economic and social inequalities. Therefore, emphasizing the growing need for designers to work with transdisciplinarity is necessary in this recent context (O'Rafferty et al., 2014).

184 In this sense, alternative teaching methods are needed to properly prepare students for the current reality and market demands. Projects conducted in universities should be debated 185 186 to increase the knowledge about teaching experiences. Ueda (2018) presented a project carried out with industrial design undergraduate students in which students needed to use eco-design 187 for product development. Eco-design is a process that considers environmental aspects with 188 the main objective of designing environments, developing products and executing services that 189 190 in some way reduce the use of non-renewable resources or minimize their environmental impact during their lifecycle (Köhler et al., 2013; Ueda, 2018; Wagner et al., 2019). Despite 191 students' interest, several challenges were found by students when it came to using support 192 tools due to their lack of knowledge, skills and experience with them (Ueda, 2018). 193

194 Focusing on the insertion of social sustainability in design education, Kjøllesdal et al. (2014) present a case study conducted in Haiti, with students from Norway. This insertion was 195 made through a project in which students needed to build a bakery for children's mothers from 196 the school of an NGO. The authors highlight as main outcomes the following items: an increase 197 198 in students' ability to solve conflicts; the development of project management skills; a holistic perspective for students; the need for students to evaluate themselves; students understanding 199 the limits of planning due to reality constraints; and contact with a different culture and society. 200 Given the information presented, it is evident that HEIs are facing a great challenge, 201

202

especially due to the transdisciplinary nature of sustainability. There is a consensus on the

importance and contribution of education to the achievement of sustainable development, and
it is necessary that these institutions adopt new teaching methods that enhance the critical
thinking of future professionals (Sinakou et al., 2019; Vargas et al., 2019). Regarding future
designers, the potential that this profession has in the promotion of a better future is obvious,
either in the spheres of new product development, projects, fashion or education.

208

209

211

212

213

1.

210 **3. Methodological procedures**

For the development of this research, five steps were performed as presented in Figure

214 215 Step 2: Data Step 1: Step 4: Debates Step 3: Content Step 5: gathering from 216 Literature considering the analysis Conclusions pedagogic review literature 217 projects 218

219 220

Figure 1. Steps followed to perform the research (Source: Authors)

221 As presented in Figure 1, step one was dedicated to the literature review. The literature review aimed to build the theoretical framework on the topics of insertion of sustainability in 222 higher education and, specifically, on the insertion of sustainability in undergraduate Design 223 courses. The scientific databases consulted were: Science Direct, Emerald Insight, Taylor and 224 Francis, Springer and Wiley. The following terms were used in the search: "Transdisciplinarity 225 critical thinking", "Education for sustainable development", "Sustainable Design professional" 226 227 and "Importance professional design". These terms were also combined with each other. Articles containing links to the the context of this study in their title, summary and keywords 228 were downloaded. The identification and extraction of information from their contents was 229 done by reading each one in full. 230

The search for pedagogical projects (step two) was performed through HEIs' websites, 231 232 which were publicly available. In this study, the pedagogical project was considered to be the document used by Brazilian HEIs to register and present all of the guidelines and characteristics 233 234 of a given undergraduate course. This document is composed of the HEIs' objectives, teaching methods, curriculum, bibliography used, and other information. It is noteworthy that in Brazil, 235 HEIs must present the pedagogical project of each of their courses in order to obtain approval 236 by the relevant bodies. Therefore, it is an important document in the context of Brazilian higher 237 238 education.

The third step was characterized by the content analysis. This analysis of the collected 239 information took place through the content analysis technique, and was performed according 240 to the guidelines proposed by Elo and Kyngäs (2008) and used by Martins et al. (2019a). 241 According to these authors, a content analysis can be performed through four well-defined 242 phases: preparation; organization; the analysis process; and the reporting of results. For this 243 study, the preparation phase (step three) consisted of the collection of pedagogical projects 244 published by HEIs that offer undergraduate courses in Design. These institutions were 245 screened, since they should make publicly available the pedagogical projects and be listed in 246 247 the Ministry of Education of the Brazilian Government. Using these boundary conditions, 30 pedagogical projects of HEI were collected and constituted the units of research analysis. 248 Therefore, the selection criteria for pedagogical projects were effectively the availability of 249 access to these sources via HEI websites. All those considered in this study are from HEIs duly 250 registered by the relevant Brazilian body. After an analysis, 30 different pedagogical projects 251 from thirty different HEIs - both public and private - were considered in this study, with a 252 large flow of students and teachers involved. This sample comprises HEIs from the 5 regions 253 of Brazil. 254

For an inductive analysis of the content presented in the pedagogical projects, according to the guidelines of Elo and Kyngäs (2008), the following steps were performed: open coding, category creation and abstraction. First, in the open coding phase, all material was analyzed, and the categories were created freely. The creation of categories increases the understanding of the studied phenomenon (Elo and Kyngäs, 2008). In this research, during the codification phase, all pedagogical projects were read in full and categories of analysis were created for a better understanding of the whole. These categories are presented in the next paragraph.

The organization phase, recommended by Elo and Kyngäs (2008), was characterized by 262 the definition of the categories to be analyzed in the pedagogical projects, aiming to identify 263 how the insertion of sustainability occurs in design courses offered by the sample HEIs. The 264 categories to be analyzed were: general objectives aimed at the professionals' training; 265 compulsory module titles and optional module titles; academic events; research groups; 266 laboratories; extension programs; and, bibliographies used. These topics were chosen due to 267 their recurrent presence in the pedagogical projects analyzed. Because of this article's scope, 268 all topics were analyzed in the context of sustainability concepts (including social, economic 269 and environmental aspects). 270

The analysis process was conducted through a careful reading of the 30 pedagogical projects collected, aiming to identify information related to the topics mentioned. Through this analysis, it was possible to gather both qualitative and quantitative information about how
sustainability has been inserted in Design courses offered in Brazil. At this stage, the main
findings were analyzed in light of the literature (step four) and conclusions were drawn. Finally,
the results were reported in article form.

It is noteworthy that, according to Elo and Kyngäs (2008), content analysis is a major challenge to be conducted. Therefore, it is very important to describe all the steps taken and highlight the limitations of the research. The detailed description of the steps performed in the research and presented in this section had this purpose. Methodological procedures have been detailed, allowing other researchers to replicate the research. The authors of this article carefully checked the information presented and agreed that the results are reliable. The exploratory character of this research is reinforced.

In order to better understand the profile of the analyzed HEIs, it is noteworthy that 60% of them are public and 40% are private. Their courses totaled six different modalities in the area of Design, with an emphasis on Bachelor of Design (47%), Interior Design (17%) and Fashion Design (17%). Figure 2 presents all the modalities identified in the sample of the studied courses. It is worth mentioning that one HEI presented a course entitled "Educational Design Technology" and has been included on the graph with the term "Educational Design".



291

292

- Figure 2. Categories of Design Courses in the sample analyzed (Source: Authors)
- 293
- 294 4. Results and Discussion

The following paragraphs present information gathered through the analysis of the 30 selected pedagogical projects, considering the topics presented in section 3. In the general objectives disseminated by the HEI themselves regarding the desired training for Design 299

1.

300

298

301

- Table 1. General objectives of pedagogic projects presented by HEIs. Source: Authors from
- 302

303

analyzed pedagogic projects

professionals, 46.66% include aspects of sustainability in these objectives, as shown in Table

#	Topic: General objectives
1	Economic and sustainable development focusing on technological innovation.
2	Focus on developing sustainable and inclusive products.
3	Promote professional humanistic training contributing to sustainable development.
4	Train professionals able to work in different areas, with innovative and sustainable proposals.
5	Professors debating the principles of sustainability in the use of natural resources.
6	Promote the sustainable development and competitiveness of Brazilian industry.
7	Develop and apply sustainable technologies in the fashion creation process.
8	Sustainability in the actions of the institution, students and staff.
9	Concerns with sustainability and the new options of insertion in productive activities.
10	Constant improvement of environmental, historical, social and economic aspects.
11	Investments in actions that relate to sustainability, considering the cost-benefit ratio.
12	Search for excellence linked to the quality of its social relations to sustainability.
13	Foster equal rights, human dignity, diversity and social and environmental sustainability.
14	Train professionals to extend global sustainability and environmental protections.
-	

It is possible to say that most HEIs aim for their design students to acquire knowledge 304 about sustainability. According to Franco et al. (2019), integrating knowledge with other 305 activities of the designer's professional routine is critical to training a professional who is 306 307 aligned with sustainable development guidelines. When analyzing the information presented 308 in Table 1 in greater detail, the following points can be highlighted: sustainable product development, innovation, the conscious use of natural resources and social sustainability. 309 Biberhofer and Rammel (2017) reinforce the importance of content alignment in the formation 310 of a professional with critical thinking skills when it comes to the sustainability of their 311 products and projects. 312

Regarding the topics "compulsory module title" and "optional module title", it was observed that only 46.66% of the HEIs present module titles related to sustainability in their curriculum. When these module titles do exist, 71.42% of them are characterized as compulsory and 28.58% as optional. Table 2 shows the required and optional module titles offered by the courses to design students.

318

Table 2. Compulsory and optional module titles of the HEIs. Source: Authors from analyzed
 pedagogic projects

	Topic: Compulsory module title		Topic: Optional module title	
(1)	Ethics and citizenship.	(1)	Environmental education.	
(2)	Design and Sustainability.	(2)	Sustainable Design.	
(3)	Design and Sustainable Development.	(3)	Design for Sustainability.	
(4)	Design, Ethics and Sustainability.	(4)	Design and Sustainable Systems.	
(5)	Design and Society.			
(6)	Social and political foundations of design.			
(7)	Design and Material Reuse.			
(8)	Ecodesign.			
(9)	Sustainable management.			
(10)	Sustainability.			

According to Hurney et al. (2016), students who attend subjects in the field of sustainability tend to have greater engagement and become more complete professionals. Despite the importance of these subjects for the training of design professionals, there are institutions that do not have them in their curriculum. Takala and Korhonen-Yrjänheikki (Takala and Korhonen-Yrjänheikki, 2019) argue that several courses are tailored to specific training in a particular area, making it challenging to address cross-disciplinary topics such as sustainability.

329 Regarding the theme "Academic events", only two analyzed undergraduate courses in design have events associated with sustainability. This can be considered critical, as this type 330 331 of event is important to disseminate knowledge and integrate students and professionals from different areas, an essential factor in training and sustainable thinking. Another possibility for 332 improvement identified in pedagogical projects is related to the number of research groups and 333 / or laboratories focused on aspects of sustainability. There are few institutions with them. The 334 content analysis carried out identified only two laboratories in the analyzed institutions that 335 were related to sustainability. That is, only 6.6% of HEIs have laboratories focused on 336 sustainability. In addition, it is also found that there are few activities related to extension 337 programs. In the analyzed sample, only two HEIs presented these activities. Table 3 provides 338 339 more information on the topics mentioned in this paragraph.

340

321

Table 3. Academic events, research groups, laboratories and extension programs. Source:

- 342
- 343

Authors from analyzed pedagogic projects.

Topic: Academic event				
(1)	Integrated Journey of the Environment.			
(2)	Week of sustainability.			
Topic: Research group				
(1)	Product Development with Amazonian Materials.			
(2)	Product Design and Sustainable Development Research Group.			
Topic: Laboratory				

(1)	(1) Design and Sustainability Center.			
(2) Model office on sustainability projects.				
Topic: Extension programs				
(1)	Sustainability and Environment Campaigns.			

344

The last topic analyzed corresponded to the survey of the main bibliographies used to insert sustainability in the design courses offered by Brazilian HEIs. Table 4 lists the main bibliographies used by these institutions.

- 348
- 349

Table 4. Main bibliographies used in the design courses offered by Brazilian HEIs for

350

sustainability education. Source: Authors from analyzed pedagogic projects.

	Topic: Bibliographies	References
(1)	System design for sustainability: theory, methods and tools for sustainable design.	(Vezzoli, 2010)
(2)	Paths for sustainable development.	(Sachs, 2006)
(3)	The basic guide to sustainability.	(Edwards, 2009)
(4)	Design for social innovation and sustainability.	(Ezio Manzini, 2006)
(5)	The development of sustainable products.	(Manzini et al., 2002)
(6)	Sustainability in interior design.	(Siân Moxon, 2012)
(7)	There will be age for light things: design and sustainable development.	(Kazazian, 2005)
(8)	Environmental Sustainability and Systemic Complexity in Industrial Product Design.	(Pereira, 2003)
(9)	Ecohouse: the environmentally sustainable house.	(Roaf et al., 2006)
(10)	Ecological literacy: children's education for a sustainable world.	(Siqueira-Batista and Rôças, 2009)
(11)	Sustainable graphic design.	(BETTONI, 2011)
(12)	Fashion & sustainability: design for change.	(Fletcher and Lynda, 2012)
(13)	The hidden connections: science for a sustainable life.	(Capra, 2002)
(14)	Environmental Education and sustainability.	(Junior and Focesi, 2005)
(15)	To think about sustainable development.	(Bursztyn, 1994)
(16)	Development: inclusive, sustainable, sustained.	(Sachs, 2004)
(17)	The myth of sustainable development: environment and social costs.	(Montibeller-Filho, 2004)
(18)	Sustainability: What it is and What it is not.	(Boff, 2012)
(19)	Sustainability and production: theory and practice for sustainable management.	(Neto, 2011)
(20)	Knowledge and sustainability: science, technology and innovation policies in contemporary Brazil.	(Baumgarten, 2008)
(21)	Sustainable design: virtuous paths.	(PELTIER et al., 2006)

351

Considering the books titles used by the HEIs in their design courses, it is possible to 352 identify a trend for the transdisciplinarity of the topics covered. For Proitz and Wittek (2019), 353 transdisciplinarity enhances professional training and the ability to solve real problems in 354 society. Additionally, O'Rafferty et al. (O'Rafferty et al., 2014) highlight that the designer 355 profession is becoming increasingly transdisciplinary due to changes in the current reality. 356 Additionally, Guerra (2017) argues that a holistic approach can cover different areas of 357 knowledge together, allowing for the integration of different concepts through the perception 358 of people from different areas. 359

Based on the results presented, it is possible to draw the following overview for the design courses offered by the analyzed institutions. Almost half of the HEIs aim to train designers in line with the objectives of sustainable development, even though they still have deficiencies in the insertion of this theme in their curriculum matrices. The range of module titles associated with sustainability is still small and in some HEIs there are no subjects associated with it. Academic events, laboratories or research groups and extension programs for sustainable development are characterized as the most critical issue identified. Regarding the set of bibliographies used, their content is interesting and can enable a proper training of design students.

369 Considering the overview previously presented and the importance of designers to meet sustainability goals, Wagner et al. (2019) highlight the increasing pressure from consumers for 370 sustainable products and services. This pressure forces professionals to meet the targets that 371 372 largely compose SDGs #9 and #12, since they are directly related to sustainable production and consumption. Similarly, Van Poeck et al. (2018) highlight that the SDGs will soon be the basis 373 of professional training worldwide. This point of view is corroborated by Li and Krasny (2019), 374 who argue that professional development programs can foster innovation and consolidate 375 changes towards sustainable guidelines. 376

377

378 **5.** Conclusions

The main objective of this article was characterized by an analysis of sustainability 379 380 insertion in undergraduate design courses offered by Brazilian Higher Education Institutions. 381 Based on the results presented, it can be concluded that the proposed objectives were achieved, even if they were only exploratory at this stage. From the data presented through the 382 pedagogical projects of 30 HEIs that offer undergraduate design courses, it was possible to 383 gather information about the general objectives of the HEIs' professional training; compulsory 384 385 module titles and optional module titles; academic events, research groups, laboratories, extension programs; and the bibliographies used. 386

As a general conclusion, it can be observed that the design undergraduate courses offered by the HEIs of the studied sample are, generally, at an early stage of sustainability insertion in their curriculum matrices. On the positive side, it should be noted that half of the institutions aim to train designers in line with sustainable development guidelines. On the other hand, there was a low number of laboratories and research groups dedicated to sustainability issues, as well as a low number of university events and extension projects.

As a research limitation, it is worth highlighting the fact that a content analysis was performed on information made publicly available by the institutions. However, this information may not always be up to date and consistent with the realities of the courses. This is a potential limitation of this study. The discussions presented here can greatly contribute to the evolution of the debate about the insertion of sustainability in the training of designprofessionals.

As for theoretical implications, it can be highlighted that the findings and debates 399 presented here contribute to the literature in the area of sustainability and sustainable education. 400 This text specifically fosters discussion aimed at improving the development of training for 401 design professionals that is focused on meeting sustainability guidelines. Regarding the 402 practical implications of this work, the debate presented in this article can contribute to those 403 responsible for the coordination of undergraduate design courses in the definition of teaching 404 405 and learning strategies, especially considering the attendance and development of sustainability themes. This is in order to prepare design students to be more prepared professionals to meet 406 sustainable challenges, as presented in the UN 17 SDGs. 407

These implications generate several proposals for possible future studies: a) An analysis of the use of active methodologies in order to enhance the theme of sustainable development in design courses by conducting multiple case studies and surveys; and b) A proposal of a set of specific guidelines for the inclusion of sustainability in design courses, especially considering their specificities. This is in addition to considering the use of sustainable indicators to analyze the landscape of design courses, highlighting their contributions to sustainable development.

415

416 **References**

- Alves, A. da S., Quelhas, O.L.G., Silva, M.H.T. Da, Lameira, V. de J., 2015. On the role of
 university in the promotion of innovation: exploratory evidences from a university-
- 419 industry cooperation experience in Brazil. Int. J. Innov. Learn. 17, 1.
- 420 https://doi.org/10.1504/IJIL.2015.066061
- Anderson, M., Teisl, M., Noblet, C., Klein, S., 2015. The incompatibility of benefit–cost
 analysis with sustainability science. Sustain. Sci. 10, 33–41.
- 423 https://doi.org/10.1007/s11625-014-0266-4
- Barata, J., Quelhas, O., Costa, H., Gutierrez, R., de Jesus Lameira, V., Meiriño, M., 2014.
 Multi-Criteria Indicator for Sustainability Rating in Suppliers of the Oil and Gas
- 426 Industries in Brazil. Sustainability 6, 1107–1128. https://doi.org/10.3390/su6031107
- 427 Barba-Sánchez, V., Atienza-Sahuquillo, C., 2018. Entrepreneurial intention among
- 428 engineering students: The role of entrepreneurship education. Eur. Res. Manag. Bus.
- 429 Econ. 24, 53–61. https://doi.org/10.1016/j.iedeen.2017.04.001
- 430 Baumgarten, M., 2008. Conhecimento e sustentabilidade: políticas de ciência, tecnologia e

- 431 inovação no Brasil contemporâneo.
- 432 Benkari, N., 2013. The "Sustainability" Paradigm in Architectural Education in UAE.
- 433 Procedia Soc. Behav. Sci. 102, 601–610. https://doi.org/10.1016/j.sbspro.2013.10.777

434 BETTONI, R., 2011. Design gráfico sustentável.

- Biberhofer, P., Rammel, C., 2017. Transdisciplinary learning and teaching as answers to
- 436 urban sustainability challenges. Int. J. Sustain. High. Educ. 18, 63–83.
- 437 https://doi.org/10.1108/IJSHE-04-2015-0078
- 438 Boarin, P., Martinez-Molina, A., Juan-Ferruses, I., 2019. Understanding students' perception
- different continents. J. Clean. Prod. 119237.
- 441 https://doi.org/10.1016/j.jclepro.2019.119237
- 442 Boehm, S., Kopec, D., 2016. Interior design as a post-disaster team partner. Int. J. Disaster
- 443 Resil. Built Environ. 7, 276–289. https://doi.org/10.1108/IJDRBE-10-2014-0075
- 444 Boff, L., 2012. Sustentabilidade: O que é e O que não é.
- Brundtland, G.H., 1987. Report of the World Commission on Environment and
 Development: Our Common Future, United Nations Commission. Oslo.
- 447 Bursztyn, M., 1994. Para pensar o Desenvolvimento Sustentável. Brasiliense.
- 448 Camioto, F.D.C., Mariano, E.B., Rebelatto, D.A. do N., 2017. Sustainability improvement
- 449 opportunities in Brazilian sectors: analysis of DEA slacks. Brazilian J. Oper. Prod.
- 450 Manag. 14, 363. https://doi.org/10.14488/BJOPM.2017.v14.n3.a9
- 451 Capra, F., 2002. As conexões ocultas: ciência para uma vida sustentável.
- 452 Cozendey da Silva, H.N., Prata, D.M., Alves Lima, G.B., Zotes, L.P., Mattos, L.V., 2018. A
- 453 techno-economic evaluation of the energy generation by proton exchange membrane
- 454 fuel cell using biogas reforming. J. Clean. Prod. 200, 598–608.
- 455 https://doi.org/10.1016/j.jclepro.2018.07.120
- 456 D'Amato, D., Korhonen, J., Toppinen, A., 2019. Circular, Green, and Bio Economy: How Do
- 457 Companies in Land-Use Intensive Sectors Align with Sustainability Concepts? Ecol.
- 458 Econ. 158, 116–133. https://doi.org/10.1016/j.ecolecon.2018.12.026
- 459 DeLong, M., Casto, M.A., Min, S., Lee, Y.K., 2016. Education for apparel sustainability
 460 from perspectives of design students from differing cultural contexts. Int. J. Fash. Des.
- 461 Technol. Educ. 9, 248–260. https://doi.org/10.1080/17543266.2016.1173234
- 462 Disterheft, A., Caeiro, S., Azeiteiro, U.M., Filho, W.L., 2015. Sustainable universities A
- study of critical success factors for participatory approaches. J. Clean. Prod. 106, 11–21.
- 464 https://doi.org/10.1016/j.jclepro.2014.01.030

- 465 Doğan, Ç., Turhan, S., Bakırlıoğlu, Y., 2016. Evolving Paths: Undergraduate Design
- 466 Education through Graduate and Generative Research with a Particular Focus on
- 467 Sustainability. Des. J. 19, 585–604. https://doi.org/10.1080/14606925.2016.1177318
- 468 Edwards, B., 2009. O guia básico para a sustentabilidade.
- Elo, S., Kyngäs, H., 2008. The qualitative content analysis process. J. Adv. Nurs. 62, 107–
- 470 115. https://doi.org/10.1111/j.1365-2648.2007.04569.x
- 471 Ezio Manzini, 2006. Design para a inovação social e sustentabilidade.
- 472 Fan, S.C., Yu, K.C., 2017. How an integrative STEM curriculum can benefit students in
- 473 engineering design practices. Int. J. Technol. Des. Educ. 27, 107–129.
- 474 https://doi.org/10.1007/s10798-015-9328-x
- Fletcher, K., Lynda, G., 2012. Moda & sustentabilidade: design para mudança. Senac São
 Paulo, São Paulo.
- 477 Franco, I., Saito, O., Vaughter, P., Whereat, J., Kanie, N., Takemoto, K., 2019. Higher
- education for sustainable development: actioning the global goals in policy, curriculum
 and practice. Sustain. Sci. 14, 1621–1642. https://doi.org/10.1007/s11625-018-0628-4
- 480 Garbie, I.H., 2017. Incorporating Sustainability/Sustainable Development Concepts in
- 481 Teaching Industrial Systems Design Courses. Procedia Manuf. 8, 417–423.
- 482 https://doi.org/10.1016/j.promfg.2017.02.053
- Gatti, L., Ulrich, M., Seele, P., 2019. Education for sustainable development through business
 simulation games: An exploratory study of sustainability gamification and its effects on
- 485 students' learning outcomes. J. Clean. Prod. 207, 667–678.
- 486 https://doi.org/10.1016/j.jclepro.2018.09.130
- 487 Guerra, A., 2017. Integration of sustainability in engineering education. Int. J. Sustain. High.
 488 Educ. 18, 436–454. https://doi.org/10.1108/IJSHE-02-2016-0022
- Hamid, S., Ijab, M.T., Sulaiman, H., Md. Anwar, R., Norman, A.A., 2017. Social media for
 environmental sustainability awareness in higher education. Int. J. Sustain. High. Educ.

```
491 18, 474–491. https://doi.org/10.1108/IJSHE-01-2015-0010
```

- Hoover, E., Harder, M.K., 2015. What lies beneath the surface? The hidden complexities of
 organizational change for sustainability in higher education. J. Clean. Prod. 106, 175–
 188. https://doi.org/10.1016/j.jclepro.2014.01.081
- 495 Hoveskog, M., Halila, F., Mattsson, M., Upward, A., Karlsson, N., 2018. Education for
- 496 Sustainable Development: Business modelling for flourishing. J. Clean. Prod. 172,
- 4383–4396. https://doi.org/10.1016/j.jclepro.2017.04.112
- Hur, E., Cassidy, T., 2019. Perceptions and attitudes towards sustainable fashion design:

- 499 challenges and opportunities for implementing sustainability in fashion. Int. J. Fash.
- 500 Des. Technol. Educ. 12, 208–217. https://doi.org/10.1080/17543266.2019.1572789
- 501 Hurney, C.A., Nash, C., Hartman, C.-J.B., Brantmeier, E.J., 2016. Incorporating
- sustainability content and pedagogy through faculty development. Int. J. Sustain. High.
- 503 Educ. 17, 582–600. https://doi.org/10.1108/IJSHE-12-2014-0180
- 504 Junior, A.P., Focesi, M.C., 2005. Educação Ambiental e sustentabilidade.
- Kazazian, T., 2005. Haverá idade para as coisas leves: design e desenvolvimento sustentável.
 Senac Nacional.
- Kirby, A., 2019. Transdisciplinarity and sustainability science: A response to Sakao and
 Brambila-Macias in the context of sustainable cities research. J. Clean. Prod. 210, 238–
 245. https://doi.org/10.1016/j.jclepro.2018.11.003
- 510 Kjøllesdal, A., Asheim, J., Boks, C., 2014. Embracing Social Sustainability in Design
- Education: A Reflection on a Case Study in Haiti. Scand. J. Educ. Res. 58, 173–188.
 https://doi.org/10.1080/00313831.2012.725095
- Köhler, A.R., Bakker, C., Peck, D., 2013. Critical materials: a reason for sustainable
 education of industrial designers and engineers. Eur. J. Eng. Educ. 38, 441–451.
 https://doi.org/10.1080/03043797.2013.796341
- Leal Filho, W., Skanavis, C., Kounani, A., Brandli, L.L., Shiel, C., Paço, A. do, Pace, P.,
- 517 Mifsud, M., Beynaghi, A., Price, E., Salvia, A.L., Will, M., Shula, K., 2019. The role of
- 518 planning in implementing sustainable development in a higher education context. J.
- 519 Clean. Prod. 235, 678–687. https://doi.org/10.1016/j.jclepro.2019.06.322
- 520 Li, Y., Krasny, M.E., 2019. Practice change in environmental education: lessons from
- 521 professional development. Environ. Educ. Res. 25, 1119–1136.
- 522 https://doi.org/10.1080/13504622.2018.1540033
- 523 Manzini, E., Vezzoli, C., Carvalho, A. de, 2002. Desenvolvimento de Produtos Sustentáveis,
- 524 O: Os Requisitos Ambientais dos Produtos Industriais.
- 525 Martins, V., Anholon, R., Quelhas, O.L.G., Filho, W., 2019a. Sustainable Practices in
- Logistics Systems: An Overview of Companies in Brazil. Sustainability 11, 4140.
 https://doi.org/10.3390/su11154140
- 528 Martins, V., Rampasso, I.S., Anholon, R., Quelhas, O.L.G., Leal Filho, W., 2019b.
- 529 Knowledge management in the context of sustainability: Literature review and
- 530 opportunities for future research. J. Clean. Prod. 229, 489–500.
- 531 https://doi.org/10.1016/j.jclepro.2019.04.354
- 532 Meyer, J., Mader, M., Zimmermann, F., Çabiri, K., 2017. Training sessions fostering

transdisciplinary collaboration for sustainable development. Int. J. Sustain. High. Educ.

534 18, 738–757. https://doi.org/10.1108/IJSHE-02-2016-0032

- 535 Montibeller-Filho, G., 2004. O mito do desenvolvimento sustentável: meio ambiente e custos
 536 sociais.
- 537 Mustapha, A.A., Mohammad, M.F., Noorhani, N.M.A., Abidin, Z.Z., 2013. Establishment
- the Scope of Work for Interior Designers. Procedia Soc. Behav. Sci. 105, 875–884.
 https://doi.org/10.1016/j.sbspro.2013.11.089
- 540 Neto, J.A., 2011. Sustentabilidade e produção: teoria e prática para uma gestão sustentável.
 541 Atlas.
- Novo-Corti, I., Badea, L., Tirca, D.M., Aceleanu, M.I., 2018. A pilot study on education for
 sustainable development in the Romanian economic higher education. Int. J. Sustain.

544 High. Educ. 19, 817–838. https://doi.org/10.1108/IJSHE-05-2017-0057

- 545 Nunes, V.G.A., 2017. Designing more responsible behaviours through Design Education:
- 546Reflections on a Brazilian pilot experience in Social Innovation for Sustainability. Des.
- 547 J. 20, S1014–S1025. https://doi.org/10.1080/14606925.2017.1353045
- 548 O'Flaherty, J., Liddy, M., 2018. The impact of development education and education for
 549 sustainable development interventions: a synthesis of the research. Environ. Educ. Res.

550 24, 1031–1049. https://doi.org/10.1080/13504622.2017.1392484

- 551 O'Rafferty, S., Curtis, H., O'Connor, F., 2014. Mainstreaming sustainability in design
- education a capacity building framework. Int. J. Sustain. High. Educ. 15, 169–187.
 https://doi.org/10.1108/IJSHE-05-2012-0044
- 554 PELTIER, F., Saporta, H., GOMES, M., 2006. Design sustentável: caminhos virtuosos.
- 555 Pereira, A.F., 2003. Da Sustentabilidade Ambiental e da Complexidade Sistêmica no Design
 556 Industrial de Produtos, Revista Estudos em Design.
- Pohlmann, C.R., Scavarda, A.J., Alves, M.B., Korzenowski, A.L., 2019. The role of the focal
 company in sustainable development goals: A Brazilian food poultry supply chain case

- 560 Prøitz, T.S., Wittek, L., 2019. New directions in doctoral programmes: bridging tensions
 561 between theory and practice? Teach. High. Educ. 0, 1–19.
- 562 https://doi.org/10.1080/13562517.2019.1577813
- 563 Ramísio, P.J., Pinto, L.M.C., Gouveia, N., Costa, H., Arezes, D., 2019. Sustainability
- 564 Strategy in Higher Education Institutions: Lessons learned from a nine-year case study.
- 565 J. Clean. Prod. 222, 300–309. https://doi.org/10.1016/j.jclepro.2019.02.257
- 566 Rampasso, I.S., Anholon, R., Silva, D., Cooper Ordoñez, R.E., Quelhas, O.L.G., Leal Filho,

study. J. Clean. Prod. 118798. https://doi.org/10.1016/j.jclepro.2019.118798

- 567 W., Santa-Eulália, L.A., 2018. An analysis of the difficulties associated to sustainability
- insertion in engineering education: Examples from HEIs in Brazil. J. Clean. Prod. 193,
- 569 363–371. https://doi.org/10.1016/j.jclepro.2018.05.079
- 570 Rampasso, I.S., Anholon, R., Silva, D., Cooper Ordoñez, R.E., Santa-Eulalia, L.A., Quelhas,
- 571 O.L.G., Leal Filho, W., Granada Aguirre, L.F., 2019. Analysis of the perception of
- engineering students regarding sustainability. J. Clean. Prod. 233, 461–467.
- 573 https://doi.org/10.1016/j.jclepro.2019.06.105
- 574 Rampasso, I. S., Siqueira, R.G., Anholon, R., Silva, D., Quelhas, O.L.G., Leal Filho, W.,
- 575 Brandli, L.L., 2019. Some of the challenges in implementing Education for Sustainable
- 576 Development: perspectives from Brazilian engineering students. Int. J. Sustain. Dev.

577 World Ecol. 26, 367–376. https://doi.org/10.1080/13504509.2019.1570981

- 578 Remington-Doucette, S.M., Hiller Connell, K.Y., Armstrong, C.M., Musgrove, S.L., 2013.
- 579 Assessing sustainability education in a transdisciplinary undergraduate course focused
- on real-world problem solving. Int. J. Sustain. High. Educ. 14, 404–433.
- 581 https://doi.org/10.1108/IJSHE-01-2012-0001
- Roaf, S., Fuentes, M., Thomas, S., Salvaterra, A., 2006. Ecohouse: a casa ambientalmente
 sustentável.
- Rodríguez-Solera, C.R., Silva-Laya, M., 2017. Higher education for sustainable development
 at EARTH University. Int. J. Sustain. High. Educ. 18, 278–293.
- 586 https://doi.org/10.1108/IJSHE-06-2015-0104
- 587 Sachs, I., 2006. Caminhos para o desenvolvimento sustentável. Garamond; Edição: 1ª.
- 588 Sachs, I., 2004. Desenvolvimento: includente, sustentável, sustentado.
- Sales Moreira, A.C., 2018. Application of the sustainable logistics plan in the public
 administration. Brazilian J. Oper. Prod. Manag. 15, 137–142.
- 591 https://doi.org/10.14488/BJOPM.2018.v15.n1.a12
- 592 Sassen, R., Dienes, D., Wedemeier, J., 2018. Characteristics of UK higher education
- 593 institutions that disclose sustainability reports. Int. J. Sustain. High. Educ. 19, 1279–
- 594
 1298. https://doi.org/10.1108/IJSHE-03-2018-0042
- 595 Schneider, F., Giger, M., Harari, N., Moser, S., Oberlack, C., Providoli, I., Schmid, L.,
- 596 Tribaldos, T., Zimmermann, A., 2019. Transdisciplinary co-production of knowledge
- and sustainability transformations: Three generic mechanisms of impact generation.
- 598 Environ. Sci. Policy 102, 26–35. https://doi.org/10.1016/j.envsci.2019.08.017
- 599 Schneiderman, D., Freihoefer, K., 2012. A pre- and post-evaluation of integrating
- sustainability curriculum by inserting Okala modules into an interior design materials

- and methods course. Int. J. Sustain. High. Educ. 13, 408–423.
- 602 https://doi.org/10.1108/14676371211262344
- 603 Siân Moxon, 2012. Sustentabilidade no design de interiores.
- 604 Sinakou, E., Boeve-de Pauw, J., Goossens, M., Van Petegem, P., 2018. Academics in the
- field of Education for Sustainable Development: Their conceptions of sustainable
 development. J. Clean. Prod. 184, 321–332.
- 607 https://doi.org/10.1016/j.jclepro.2018.02.279
- 608 Sinakou, E., Boeve-de Pauw, J., Van Petegem, P., 2019. Exploring the concept of sustainable
- 609 development within education for sustainable development: implications for ESD
- 610 research and practice. Environ. Dev. Sustain. 21, 1–10. https://doi.org/10.1007/s10668611 017-0032-8
- 612 Siqueira-Batista, R., Rôças, G., 2009. Alfabetização ecológica. Rev. Bras. Educ. Med. 33,
 613 123–125. https://doi.org/10.1590/s0100-55022009000500014
- Souleles, N., 2017. Design for social change and design education: Social challenges versus
- 615 teacher-centred pedagogies. Des. J. 20, S927–S936.
- 616 https://doi.org/10.1080/14606925.2017.1353037
- 617 Stephens, J.C., Hernandez, M.E., Román, M., Graham, A.C., Scholz, R.W., 2008. Higher
 618 education as a change agent for sustainability in different cultures and contexts. Int. J.

619 Sustain. High. Educ. 9, 317–338. https://doi.org/10.1108/14676370810885916

- Takala, A., Korhonen-Yrjänheikki, K., 2019. A decade of Finnish engineering education for
 sustainable development. Int. J. Sustain. High. Educ. 20, 170–186.
- 622 https://doi.org/10.1108/IJSHE-07-2018-0132
- Tejedor, G., Segalàs, J., Rosas-Casals, M., 2018. Transdisciplinarity in higher education for
 sustainability: How discourses are approached in engineering education. J. Clean. Prod.
- 625 175, 29–37. https://doi.org/10.1016/j.jclepro.2017.11.085
- 626 Ueda, E.S., 2018. Student team integrating aspects of sustainability in practical design
- education. Int. J. Sustain. High. Educ. 19, 877–892. https://doi.org/10.1108/IJSHE-082017-0136
- UN, 2017. Global indicator framework for the Sustainable Development Goals and targets of
 the 2030 Agenda for Sustainable Development.
- 631 UNESCO, 2017. Education for Sustainable Development Goals Learning Objectives. United
 632 Nations Educational, Scientific and Cultural Organization, Paris.
- Van Poeck, K., König, A., Wals, A.E.J., 2018. Environmental and sustainability education in
 the Benelux countries: research, policy and practices at the intersection of education and

- 635 societal transformation. Environ. Educ. Res. 24, 1234–1249.
- 636 https://doi.org/10.1080/13504622.2018.1477121
- 637 Vargas, V.R., Lawthom, R., Prowse, A., Randles, S., Tzoulas, K., 2019. Implications of
- 638 vertical policy integration for sustainable development implementation in higher
- education institutions. J. Clean. Prod. 235, 733–740.
- 640 https://doi.org/10.1016/j.jclepro.2019.07.022
- 641 Verhulst, E., Van Doorsselaer, K., 2015. Development of a hands-on toolkit to support
- 642 integration of ecodesign in engineering programmes. J. Clean. Prod. 108, 772–783.
 643 https://doi.org/10.1016/j.jclepro.2015.06.083
- 644 Vezzani, V., Gonzaga, S., 2017. Design for Social Sustainability. An educational approach
 645 for insular communities. Des. J. 20, S937–S951.
- 646 https://doi.org/10.1080/14606925.2017.1353038
- 647 Vezzoli, C., 2010. Design de Sistemas Para a Sustentabilidade. Edufba, Salvador.
- 648 Wagner, M., Curteza, A., Hong, Y., Chen, Y., Thomassey, S., Zeng, X., 2019. A design
- analysis for eco-fashion style using sensory evaluation tools: Consumer perceptions of
 product appearance. J. Retail. Consum. Serv. 51, 253–262.
- 651 https://doi.org/10.1016/j.jretconser.2019.06.005
- 652 Zeiny, R.M.A.E.-, 2012. Sustainability in the Education of Interior Designers in Egypt.
- 653 Procedia Soc. Behav. Sci. 38, 122–131. https://doi.org/10.1016/j.sbspro.2012.03.332

654