BIRMINGHAM CITY University

SUPPORTING THE SUSTAINABLE DEVELOPMENT OF MEXICO: AN INVESTIGATION INTO THE REORIENTATION OF AN UNDERGRADUTATE INDUSTRIAL DESIGN CURRICULUM

A Doctoral Thesis. Submitted as a requirement for the award of Doctor of Philosophy of Birmingham City University by the author

Martha Elena Núñez López

Faculty: Arts, Design and Media

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Abstract

The Government of Mexico's five-year national development plan (PND) identifies the need for quality education to 'make scientific, technological, and innovation development pillars for sustainable economic and social progress' (PND, 2013). The literature on sustainable development (SD) highlights the complexity of the subject and how the meanings of SD evolve according to local contexts (UNESCO, 2010). The impetus for this practitioner-led action inquiry stems from the inquirer's belief that more research efforts are needed to improve education for sustainable development (ESD) in higher education, in Mexico. In this national ESD context, the inquiry explores ways of reorienting the undergraduate's Industrial Design curriculum at Tecnologico de Monterrey (TEC), in Mexico.

The research is structured in three cycles. The first explores the scope of the inquiry. This informs the second cycle in which curriculum interventions investigate the inclusion of SD content and assessment criteria in the Industrial Design curriculum at TEC's Puebla campus. The creation of an online SD learning space emerges from the interventions. This initiative gains momentum as the inquiry proceeds. The third cycle comprises Focus Groups. These invite the participants in the research to reflect upon and respond to the findings from the interventions. The collaborative methods of the interventions, combined with the online learning space, inspired a creative and collaborative approach to educational change, resulting in the reorientation of the Industrial Design curriculum. The outcomes of the study exemplify the ability of practitioner-led action research to address complex problems across national and global sustainability agendas, involving the motivation and commitment of others in contributing to improving education for sustainable development in Mexico.

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List of Publications

1. Nunez, M.E. et al., 2021. ‘Evaluating the development of Sustainability competencies and knowledge in the Architecture and Design students’. 7th International Conference on Education (ICEDU 2021), Empowering learners in a digital world, Sri Lanka.

2. Nunez, M.E. et al., 2020. ‘Promoviendo la educación para el desarrollo sostenible mediante recursos en línea’. Poster presentation. International Conference of Educational Innovation, Tecnologico de Monterrey, Mexico.

3. Nunez, M.E. et al., 2020. ‘Promoting Sustainable Development Education through Competency-based Education Supported by Online Resources’. The 4th International Conference on Digital Technology in Education, Busan South Korea.

4. Nunez, M.E. et al., 2019. ‘Integrating Sustainable Development into the Curriculum - A case study on the developing of Sustainability competencies in Industrial Design students at a Bachelor level in Mexico.’ International Higher Education Teaching and Learning Education, UK. https://doi.org/10.1108/S2055-364120200000018022

5. Nunez, M.E. et al., 2019. ‘Caso de estudio sobre la integración de competencias en desarrollo sostenible en el plan de estudios’. International Conference of Educational Innovation, Tecnologico de Monterrey, Mexico. ISSN: 2594-0325.

6. Nunez, M.E. et al., 2018. ‘Apoyando el Desarrollo sostenible de México a través de la exploración de enfoques innovadores en el plan de estudios de diseño industrial en la educación superior’ International Conference of Educational Innovation, Tecnologico de Monterrey, Mexico. ISSN: 2594-0325.

7. Nunez, M.E. et al., 2018. ‘Enfoques innovadores en la enseñanza de Diseño Industrial’. Edubits, Tecnologico de Monterrey. https://observatorio.tec.mx/edu-bits-blog/enfoques-innovadores-ensenanza-diseno-industrial

8. Nunez, M.E. et al., 2017. Poster: ‘Supporting Mexico’s Sustainable Development Through Exploring Innovative Approaches to the Product Design Curriculum in Higher Education’. Poster Presentation, Festival of Teaching, Birmingham City University.

Contents

Chapter 1. Introduction

1.1 Introduction to the inquiry

> It is from the universities where the first step is taken to obtain qualified personnel who work with their knowledge in the innovative processes of the labour world.
> (Herrera et al., 2007)

This educational case study addresses the ‘quality education goal’ of the government of Mexico’s National Development Plan, 2013 (PND) and the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Transforming our World: 2030 Agenda for Sustainable Development’s (UNESCO 2017, p.1). In addressing these agendas, the study explores a contextual framework of interrelating discourses on the profession and discipline of industrial design, sustainable development (SD) and education for sustainable development (ESD). Definitions of SD and its evolving nature are introduced below (p.34). The study centres on the Industrial Design undergraduate programme at Tecnologico de Monterrey (TEC), in Mexico, where the *Licenciatura* (Bachelor's) degree, is aligned to the Bologna process (Cepeda & Gascon, 2009). The concept of interconnecting local, national and global contexts (Fallan & Lees-Maffei, 2015, p.1) is outlined in Chapter 2, the Literature Review (p.37) and discussed as the thesis develops.

The research design framework of the study is informed by the literature on ‘practitioner-led action inquiry' (Stenhouse, 1975). This enables the inquirer to use her own educational experiences to investigate a specific curriculum at TEC, where the inquirer is Professor. The inquiry comprises three cycles: Cycle 1, concentrates on developing an understanding of the scope of the study. This cycle, named the Curriculum Scoping, involves collecting data from

the stakeholders in the inquiry: Industrial Design and Architecture students and teachers / professors at TEC, and external experts; academic, professional, business and international participants. An important feature of the research design is that most of the research methods are undertaken at TEC, enabling stakeholder engagement in the Curriculum Inquiry. The second cycle (Cycle 2) applies interventions to the Industrial Design curriculum. The interventions test the use of SD-oriented competencies Informed by Cycle 1, in combination with the Literature Review, the competencies are formulated to support the integration of sustainability into the Industrial Design curriculum and evaluate the students' SD learning, resulting from the interventions. In Cycle 3, the main findings from the interventions are presented to Focus Groups, comprising the students and professors who participated in the interventions and most of the academic and professional experts who contributed to the Curriculum Scoping in Cycle 1.

During the reconnaissance period of this study (McNiff et al., 2003), the inquirer recognised that fundamental curriculum change would be needed to contribute to improving the sustainable development of Mexico (Nunez, et al., 2019). This view was informed by the inquirer's experience of teaching on the Industrial Design programme and contributing to local and national educational debates. Approaches to curriculum change are introduced below (p.18) and explored in the Literature Review (Chapter 2, pp.37-40). According to the UNESCO (2012), SD topics, are 'complex and are often difficult to define as well as find solutions for' (UNESCO, 2012, p.6). For Klarin (2018, p.67), although the development of the concept of SD has undergone 'different critiques and interpretations over time', [the concept has been] accepted in different areas of human activity [and] the underlying principles and goals [of SD], as well as the problems of their implementation, remained almost unchanged'. However, 'some goals have been updated' and new goals have been set. Klarin goes onto explain that:

> [t]hese goals are united in the framework of the Millennium Development Goals 2015 which outline the challenges that humanity has to fight not only to achieve sustainable development but to survive on Earth as well.
> (Klarin, 2018, p.67)

The inquirer considers that this emphasis on achieving SD and caring for the survival of Earth, as interdependent goals, provides a working basis for this study. For Griggs et al. (2014) SD is the:

> [d]evelopment that meets the needs of the present while safeguarding Earth’s life support system, on which the welfare of current and future generations depends.
> (Griggs, et al., 2014)

The earlier definition of SD published by the Brundtland commission, focused on the 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World CED, 1987 cited in Stebbing & Tischner, 2015, p.9). By comparison, the more recent definition stresses that 'Earth’s life support system' is an essential basis for continuing 'social, cultural and economic development and existence Stebbing & Tischner, 2015, p.9). Stebbing and Tischner (2015) adopt the Griggs et al. definition because it emphasises the interdependency between 'ecosystems and economies' (Stebbing & Tischner, 2015, p.9).

The UNESCO (2017, p.12) states that education for sustainable development (ESD) requires the integration of sustainability content into the curriculum and that education requires changes in pedagogy, including the development of participatory approaches that can engage and motivate students and result in actions towards a sustainable future (UNESCO, 2017, p.12). The term of education for sustainable development and its abbreviation, ESD, is used throughout this thesis, as education *for* sustainable development (the inquirer's italics), reflects the intended emphasis of this inquiry on the application of SD learning in practice. The Literature Review outlines the government of Mexico's 'quality education goal' (PND, 2013). This national context is then discussed in relation to local, national and international discourses on SD and ESD (p.79). In this way, the review of the literature investigates a range of perspectives and how they inform the development of this Curriculum Inquiry at TEC, in Mexico.

1.1.1. Introduction to the government of Mexico development plans

The 'Plan Nacional de Desarrollo' (PNDs) 2013-2018 PND, published in 2013, specified the objectives of policies and programmes of the Government of the Mexican Republic, including specific actions and measurement indicators. In 2019, this plan was replaced by a new PND 2019-2024. As this was published during this study, in May 2019, references to the educational and sustainable development objectives of both plans are included in this thesis. The content and differences between the two plans, relevant to the study, are discussed later in this chapter (p.30). The focus of the 2013-2018 PND was to bring Mexico to its full potential. The five goals of the PND (2013-2018), which are also the five progress measurement indicators, are: (1) Mexico in peace, (2) an inclusive Mexico, (3) Mexico with quality education, (4) a prosperous Mexico and (5) Mexico with global responsibility.

The 2019-2024 National Development Plan (PND) resulted from the presidential election, in December 2018, of Andrés Manuel López Obrador of the National Regeneration Movement (MORENA). During the election campaign, Obrador presented the 'Nation Project 2018-2024'. This was replaced in May 2019, by the 2019-2024 MORENA PND. The relationship between the study and the educational objectives of the PND´s is outlined below (p.30).

1.1.2. The educational agenda of the PND

The diagram below, Figure 1, illustrates the national educational context of this case study; the Government of Mexico's 'quality education goal' and objective, to define 'relevant learning objectives and learning contents' to support the country's 'sustainable economic and social progress' (PND 2013, p.22).

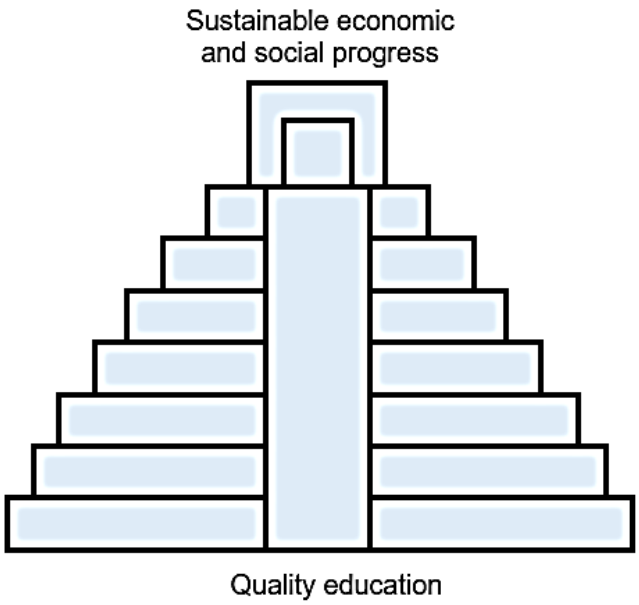


Figure 1: The PND's 'quality education goal [supporting] sustainable economic and social progress'

Figure 2 below, illustrates the case study. The three intersecting circles represent the contextual framework of the study, comprising: (i) addressing the PND and UNESCO agendas; (ii) reorienting the Industrial Design curriculum at TEC (iii) investigating design education for sustainable development; informed by local, national and global design, SD, and ESD contexts. The four concentric circles represent the levels within which the contextual framework is explored, with the new Design curriculum at TEC shown, as a target, at the centre of the circle.

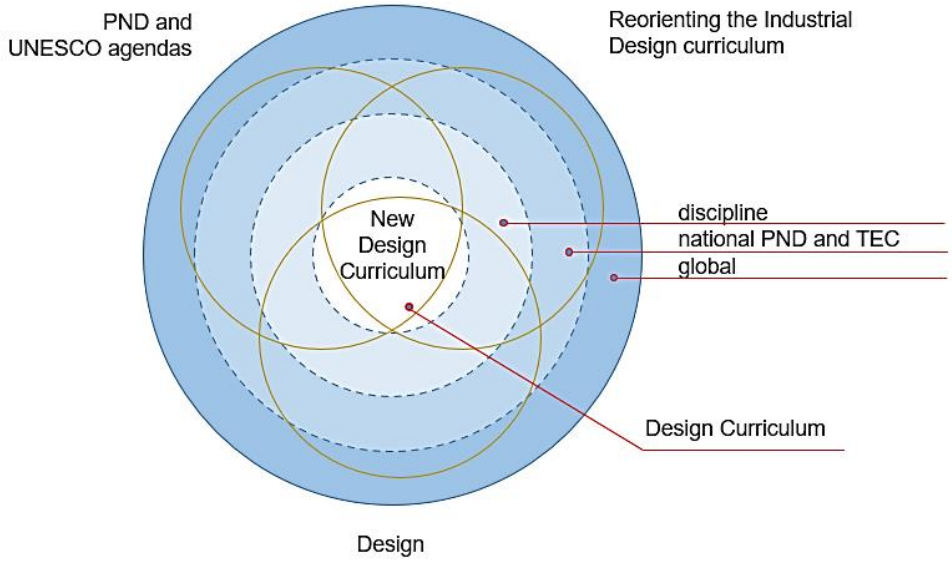


Figure 2: The case study

1.1.3. The education agenda of Mexico's largest University

Tecnologico de Monterrey is Mexico’s largest higher education institution, with 36 campuses located across the county's five zones. Concurrently with this inquiry, the University is renewing its curricula, aligned to the University's Tec21 Educational model (established in 2019). The reorientation of the Industrial Design curriculum at TEC, alongside the University's Tec21 Educational Model, provides the real-world context for the inquiry. As a core feature of this model, the position of Competency-Based Education (CBE) in the inquiry is discussed further in the Literature Review (Chapter 2), in relation to design, SD and ESD (pp.49-50).

As introduced above (p. 12), practitioner-led action inquiry supports the undertaking of this case study. Chapter 3 (p.77) provides an overview of the research design, including details of the structure of the Curriculum Inquiry in three cycles and the methods applied in each cycle. The national setting of the inquiry affords an opportunity to contribute to Mexico’s ‘sustainable development and social progress' (PND, 2013). At the same time, as the Literature Review identifies, '[d]esign is simultaneously global, regional, national, and local' (Calvera, 2005 cited in Fallan & Lees-Maffei, 2015, p5). Therefore, through exploring methods of integrating SD into the Design curriculum at TEC, the inquirer believes that the research has the potential to contribute to ESD discourses and curricula research projects at TEC and at other universities in Mexico and abroad.

1.1.4. Approaches to curriculum change

As highlighted above (p.13), the inquirer recognised that fundamental curriculum change would be needed the address the PND and UNESCO agendas, as outlined above. This level of change is seen as necessary to enable the development of effective SD learning and as a realistic objective within the scope and timescale of the study. The Literature Review explores

approaches to curriculum change in relation to the subjects of design, SD and the planned reorientation of the Industrial Design curriculum.

1.1.5. Concepts of sustainable development

According to Tangi (2005 cited in Klarin, 2018), 'the notion of development [as it] related to the past western concept of imperialism and colonialism' had negative connotations, 'associated with infrastructure development, political power, and economic policy, serving imperialists as an excellent tool for marginalization and diminishing the power of certain countries' (Klarin, 2018, p.68). Sharpley (2000 cited in Klarin, 2018, p.68), considers that 'development and sustainability could be in the juxtaposition, where both could have possible counterproductive effects' (Klarin 2018, p.68). By comparison, Sachs (2010 cited in Klarin, 2018, p.68), suggests that development and sustainability are interdependent and that to achieve 'complete sustainable development' the 'three pillars of sustainability' (environmental, social and economic) must be held in balance (Klarin, 2018, p.68). These perspectives exemplify the contested, complex and evolving nature of sustainable development. The Literature Review (p.35) discusses how the nature of SD informed the Curriculum Inquiry.

The inquirer believes that the process of reorienting curricula, to improve ESD in Mexico, should involve the participation of and be of benefit to all stakeholders in SD and ESD. For the purposes of this research, the concept of stakeholders accords with Freeman's inclusive definition of stakeholders as ‘any group or individual who can affect or is affected by the achievement of the firm’s objectives’ (Freeman, 1984, p.16, cited in Jongbloed et al., 2008, p.305).

1.2. Overall and specific objectives of the research

The overall objectives of the research are to:

1. integrate sustainable development (learning methods and approaches) into Tecnologico de Monterrey's Industrial Design curriculum.
2. contribute to integrating sustainable development into Tecnologico de Monterrey's educational initiatives, enabling the continuous development of the curriculum.

The specific objectives of the research are to:

1. create innovative learning and teaching methods and develop an understanding of how they can contribute to integrating SD into the Industrial Design curriculum at TEC
2. engage in and contribute to international communications on design education for sustainable development, based on perspectives drawn from the setting of the inquiry in higher education in Mexico
3. support the development and implementation of Competency-Based Education: enabling students to develop the competencies needed to make informed and responsible decisions

1.3. Research context and background to the study

1.3.1. Research context

Inspired by the Massachusetts Institute of Technology, U.S.A., Tecnologico de Monterrey (TEC) was established in Monterrey, Mexico, in 1943, The University's Industrial Design programme commenced in 2000. Created by the architect and scholar, Hermas Haaz, this programme was founded with the aim of educating professionals to design and develop new products, services

and user-centred experiences within different industrial sectors. Graduates are expected to work in different companies, in social and environmental oriented organisations and in the government; they are also expected to contribute to organisations, as independent external consultants or as entrepreneurs through their own company based on design (TEC, 2016).

As outlined above (p.18), this inquiry is proceeding alongside the Tec21 Educational Model. This model, which frames the principles and design of the University's curricula, introduces the use of competencies for the first time at TEC. The teaching of the new curriculum commenced in August 2019. Aligned with this institutional level of change, the Curriculum Inquiry investigates the learning and teaching experiences of Industrial Design students and professors. Their experiences are based on their participation in Curriculum Interventions, comprising Project courses. These courses use competencies, which were formulated for the interventions and informed by the inquiry. Relevant aspects of the literature on the system of CBE are discussed in Chapter 2 (p.56) and Chapter 4 outlines the development of the competencies and presents the results of their application, as measured through Student Course Surveys, in Cycle 2. (p.148).

The development of TEC's new undergraduate curricula is, at the time of writing, undertaken by the university's Academic Aspects Undergraduate Team (EAAC), comprising professors from four of the university's campuses. This team oversees the detailed design of each programme in conjunction with other participating professors. The inquirer directed the EAAC's development of the plan for the new undergraduate Design curriculum (2017) and contributed to directing the EAAC's plan for the undergraduate Architecture curriculum (2019-2021).

1.3.2. The inquirer’s background leading to the study

It is worth noting that this is the only section in this thesis in which the first person is used. This is because it presents the inquirer’s own background and motivations for undertaking the study.

I began my higher education study in Architecture as an undergraduate student at TEC in August 1994, and ever since then, I have always considered myself fortunate to have been given this opportunity. I received a 90% scholarship to study at the University's high school and undergraduate programme in Architecture. Subsequently I gained a 100% scholarship to study for a Master of Science degree in Civil Engineering and Construction Management, and a few years later, after becoming a teacher at TEC, I received further support from the University, equivalent to 100%, to obtain a second taught postgraduate degree in Industrial Design and Product Innovation.

After graduating from the undergraduate Architecture programme, I worked for three years (1999-2002) in an 'architecture buffet'. This work involved teaching courses on various architectural software and it was through this experience that I discovered my interest in teaching. Concurrent with this employment, I studied for the above-mentioned Civil Engineering and Construction Management programme and undertook architectural projects (2000-2001). At that time, my motivation to study at Master's level was to meet the requirements to teach at TEC and from a more personal point of view, to gain the knowledge and experience necessary to enter into teaching with a firm foundation of theoretical and practical knowledge. After completing the Master's programme, I worked for two years in a construction company, which develops social housing complexes. In August 2004, during the second year of working for this company, I was invited by TEC to give my first class as a part time teacher.

I have always felt a great sense of gratitude for these opportunities, and this only has increased since learning more about the statistics on the participation of Mexican people in higher education. Mexico has ‘the lowest number of higher education students among the OECD countries’ (Expansion 2017). Only 17% of Mexicans study at a higher education level, 4% progress to graduate studies and less than 1% at Ph.D. level (Expansion 2017; (Mexicanos primero, 2016). Poverty in Mexico is a significant factor, which prevents people from entering university. When I began planning to study for a Ph.D., I decided that I wanted the research to contribute to improving the sustainable development of Mexico. The low participation of people in Higher Education in Mexico is a barrier to improving SD in the country. However, I prefer to see this as a problem for the research to contribute to solving. TEC recognises that poverty has a significant detrimental impact on higher education participation and the university's initiatives to address this problem include the ‘Líderes del Mañana” programme. This programme, which started in 2014, enhances the training and development of bright and talented young Mexicans who, due to their economic and social status, require 100% scholarships to enable them study at TEC.

After one year of part-time teaching at TEC, I decided to leave the construction company to dedicate more time to teaching at the University. Reflecting on this decision, I believe that I was attracted to higher education for two main reasons. I perceived that teaching would offer the flexibility I needed to give more time to my family and was inspired by the opportunities that higher education could offer; in particular, to contribute to the development of future generations of industrial designers. With respect to this Ph.D. study, I have also reflected on how my early teaching experience, enabled me to engage in experiential learning and experimentation. These opportunities are discussed in the review of literature (p.73), in relation to the need to develop students' 'higher-order' thinking processes (Mezirow, 1990, p.2).

As a part-time teacher, the continuity of employment at TEC could not be assured from one semester to the next and after only five months of teaching, the University's newly appointed Director of the Architecture Department had not planned to continue my teaching classes. However, at this same time I received an award from the Principal of TEC for being the best teacher in the Engineering and Architecture Division. This was the outcome of a student surveys completed at the end of each semester to evaluate their learning and teaching. The award gave me great satisfaction and importantly for my future career, it provided evidence, for the new Architecture Director, of my teaching ability. As a result, my teaching at TEC continued, and since 2004, I have held the position of professor of Design and Architecture and in 2008 I was made a full-time professor and Director of the Industrial Design Undergraduate's programme. During these years (2008-2010), I studied for my second Master's degree (Industrial Design and Product Innovation), from which I graduated with the highest honours. The main reason for studying this second postgraduate degree was that at TEC, a professor can only teach in departments that are directly linked to their discipline at this level.

Since July 2021, my position at TEC is Director of the Design Bachelor programme at the Monterrey campus. The previous positions I held at TEC were Director of the Architecture Department - South Region (June 2017 – December 2020); National Coordinator of the Architecture, Design and Arts Academies (May 2016 - August 2017); Academic Director of the Industrial Design Department (January 2011 - January 2016) and Director of the Industrial Design undergraduate programme (January 2008 - January 2011).

The original motivations for this Curriculum Inquiry, which the reconnaissance period of the study contributed to focusing, were based on:

1. observing how students learn more effectively in learning environments where traditional and digital technologies and methods are combined
2. a growing interest in and commitment to improving social design education and
3. connecting the Industrial Design curriculum at TEC to global discourses on education for sustainable development

These motivations are discussed below and as the thesis develops.

1. Innovative learning spaces: Supported by a learning and teaching initiative at TEC, in March 2015, I introduced a combination of traditional and digital technologies to a theoretical course in the Industrial Design programme. This course had previously been taught using traditional classroom methods alone. Feedback from students who participated in this course helped to validate my belief that students are more likely to learn effectively in environments where traditional and digital methods are innovatively combined.

> Key to innovation is interactive content that encourages the active participation of students and teachers in exploring and exchanging information.
> (PACE, 2007, p.1)

This approach to learning is explored later in this thesis in relation to encouraging social and collaborative innovation (p.65).

2. Social design education: Since 2014, I have promoted student collaborative design projects with an emphasis on cross-citizenship (Experiences Design course). These have included: (i) the designing and prototyping of toys for children with special educational needs. These projects involve participatory design methods in which the students interview the children's teachers, at their schools, to develop an understanding of the design brief; (ii) working with companies connected to the Business Social Incubator at TEC. For example, the design of a cafeteria dedicated to employing young people with special educational needs.

As a member of the Royal Society of Arts (RSA) in 2017-2018, I promoted the participation of TEC students in the RSA Student Design Awards. This competition challenges students to tackle urgent social, environmental and economic problems through design. Three TEC students won RSA Student Design Awards in the 2017 competition.

3. Internalisation in learning and teaching: As Academic Department Director, I have organised student summer programmes in the United Kingdom, Japan, China and Thailand (2013 – 2019), invited visiting professors from Poland, Japan and Brazil to participate in a one-year programme at TEC and invited academic leaders from India, the United Kingdom, Japan, Brazil, Netherlands, Poland and Puerto Rico to provide workshops and courses at TEC. These initiatives offer students in Industrial Design opportunities to broaden their knowledge of different international design contexts and perspectives.

Presentations, based on this research, have included national and international fora and through these experiences, I have observed how technology-mediated courses, taught by subject-experts and academics from abroad, complemented traditional classes and helped the students, as citizens of the world, to engage in global perspectives. In this regard, it is important to recognise that, for economic reasons, not all students at TEC are able to participate in opportunities such as summer schools abroad and internships.

1.4. The scope of the inquiry

The national context of TEC (p.18) enables the inquiry to collect data from the university's Industrial Design programmes in three of the five zones of Mexico. The national scope of the inquiry is also supported by involving the participation of stakeholders in six public and eight private universities in Mexico. Through these national and regional data sources, the inquiry focuses on educational approaches to Industrial Design, in the context of the challenges of Mexico's sustainable economic and social progress. During this inquiry, the title of the Industrial Design programme at TEC was changed to Design. Industrial Design was the title of the programme at the start of this inquiry, as it applied to the university's 2011-2017 curricula. It is worth noting that the title of Product Design has a similar meaning to Industrial Design. In general, the former encompasses the design of a range of products, for example, services and software design, as well as industrially manufactured products. By comparison, Industrial Design tends to be associated with the Industrial Revolution. Design became the course title at TEC from the start of the 2019-2020 curricula. For the purposes of this study, the terms 'design' and 'industrial design', when not capitalised, refer to their generic meaning and 'Industrial Design' and 'Design', when capitalised, are used in relation to disciplines of study.

The Curriculum Inquiry at TEC enables findings to be considered and interpreted by other Mexican universities with similar course structures, in relation to their regional contexts. Other stakeholders in the research include students, industry stakeholders, leaders and experts as well as policy makers. The overall organisation of the Curriculum Inquiry comprises three cycles. These are shown in the next table (Table 1). These cycles are discussed in more detail in Chapter 3 (p.89).

Table 1. The cycles of the Curriculum Inquiry

Cycle	Description
Cycle 1	The Curriculum Scoping: developing an understanding of the scope of the inquiry; methods comprising:
	Interviews with Experts in Mexico and the UK
	A Community of Practice seminar
	A Nationwide Questionnaire: existing SD learning teaching approaches in in Design in Higher Education in Mexico
	Interviews at TEC: students, graduates and professors from four different campuses of TEC
Cycle 2	Curriculum Interventions / Students Course Surveys (Competency-Based Education)
Cycle 3	Focus Groups: eliciting the opinions and viewpoints on the main findings from the Curriculum Interventions from the stakeholders / participants in the study

As introduced above, the inquiry addresses the Government of Mexico's periodic five-year PNDs. The new Mexican Government *National Development Plan 2019-2024* (PND) document identifies that one of the internal priorities for Mexico is to support education. One of the ways identified in this plan is to address education through the 'Benito Juarez National Scholarship Programme for Welfare'. This programme enables young people under eighteen years of age from homes in situations of extreme poverty to study in a public school; from initial and basic education to higher secondary education and higher education. Another initiative is the 'Young people writing the future' scholarship. This national scholarship enables citizens, under the age of twenty-nine, from low-income backgrounds to study in higher education (Government of the Mexican Republic, 2019, pp.39-41). This plan's priorities also include support for health, science and technology, the fight against corruption, poverty and inequality, accompanied by an impulse to justice. There is a relationship between this and the 'Líderes del Mañana' programme at Tec de Monterrey, which, as identified above (p.23), awards study

scholarships to students, who for economic reasons would otherwise be unable to study in higher education

> No young person who wishes to pursue an undergraduate's degree will be left out of higher education due to the lack of places in the universities and none will be condemned to unemployment, underemployment or informality.
> (Government of the Mexican Republic, 2019, p.62).

The PND also recognises the concept of SD as an important driver for the country's development. The PND states that the Federal Executive Power will consider the impact of its policies and programmes on ecology, politics and economy of the country. It also promises that it will provide a guide to 'development that overcomes social injustices' and to the promotion of 'economic growth without causing harm to peaceful coexistence, solidarity ties, cultural diversity or the environment' (PND 2019, p.37).

> The Mexican government is committed to promoting sustainable development, which in the present era has proven to be an indispensable factor of well-being. It is defined as meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. This formula summarises unavoidable ethical, social, environmental and economic mandates that must be applied in the present to guarantee a minimally habitable and harmonious future.
> (Government of the Mexican Republic, 2019, p.38).

The importance of SD and education objectives in the new PND (2019-2024) is similar to the previous PND (2013-2018). However, the inquirer considers that a difference between the two documents is that the programmes and policies of the new PND reflect to a greater degree the socialist priorities of the (MORENA) government. For example, it specifies the objectives of equal rights, freedom and opportunities for all people. The new PND document also promotes the interconnected social and technological SD objectives of the transition of energy sources and reindustrialisation; the 'incorporation of populations and communities to the production of energy from renewable sources, to provide electricity to small isolated communities' (Government of the Mexican Republic, 2019, p.52).

1.5. The research question

This research addresses the following question:

> In what ways can innovations in Design education, for sustainable development (in higher education), contribute to developing 'relevant learning objectives and learning contents' toward achieving the 'quality education goal' of Mexico (PND 2013).

1.6. The structure of the thesis

The thesis comprises six chapter. This chapter introduced the contextual and research design frameworks of the study, including the inquirer's motivations behind the study. This led into outlining the scope and organisation of the study, defining the overall and specific objectives of the Curriculum Inquiry, and the research question. The next chapter (Chapter 2) reviews the literature on design, sustainable development (SD) and education for sustainable development (ESD). It discusses their mutually influencing contexts in relation

to design (Calvera, 2005, cited in Fallan & Lees-Maffei, 2015, p.5) and develops from investigating the larger problem of improving ESD and SD in Mexico, to focusing on the development of the profession and discipline of Industrial Design in Mexico and how the selected literature influences and informs approaches to the reorientation of the Industrial Design curriculum at TEC.

Chapter 3 outlines and discusses the inquirer's research-informed and practical justifications for the selection of the overall design and methods of the inquiry; the three cycles of the Curriculum Inquiry in relation to the educational context of the study at TEC. The research design and specific methods of the inquiry were also informed by considerations of the Ethical Principles and Practice Policy Statement of Birmingham City University and equivalent principles and practices of TEC. The final section of Chapter 3 describes aspects of the alignment of the inquirer's selection and use of research methods to these ethical principles and practices.

Chapter 4 is dedicated to the three cycles of the Curriculum Inquiry. It presents and analyses the main findings from the data collected from the Curriculum Scoping (Cycle 1) and Curriculum Interventions (Cycle 2) with a focus on how the scoping of the inquiry informed the interventions, including the formulation of SD-competencies for the interventions and the ways in which the findings from the interventions contributed to achieving the research objectives and answering the research question. Chapter 4 concludes by presenting the results from the Focus Groups (Cycle 3), which invited the participants to consider the findings from the Curriculum Interventions.

Chapter 5: One of the specific objectives of this study is to create innovative learning and teaching methods and to develop an understanding of how they can contribute to integrating SD into the Industrial Design curriculum at TEC (p.20). During the reconnaissance period of the research, the inquirer had considered developing electronic learning resources. However, this possibility was not included in the planned research methods as it was too approximate

at that time. Later in the research, the participating students and professors in the first Curriculum Intervention (September 2019), reported that they needed more SD information sources to support their projects. This gap led to the creation of an online learning space (later named Sostek), at TEC, which contributed to the development of an important pedagogy for the interventions and subsequently, the Industrial Design curriculum. For this thesis, the inquirer will refer to the online resource and similar actions, which respond to findings and opportunities arising during the inquiry, as unplanned activities: to distinguish such actions from the planned methods of the research.

Chapter 6 presents the conclusions drawn from the planned and unplanned methods of this case study. It begins by discussing the ways in which the main findings drawn from inquiry contributed to achieving the research objectives and answering the research question. This is followed by proposing how the research contributes to knowledge in the field of ESD, discussing the limitations of the Curriculum Inquiry arising from its scope and methodology and outlining recommendations for future research in the field of ESD.

Chapter 2. Literature review

2.1. The strategy for the sourcing literature

A specific objective of this inquiry is to contribute to international communications on design education for sustainable development, by drawing upon the findings from this inquiry, in higher education in Mexico. Toward achieving this objective, the Literature Review explores the results of other studies and ongoing discourses relevant to the inquiry and seeks to establish a basis of knowledge to inform and guide the Curriculum Inquiry as a whole (Cooper, 2010; Marshall & Rossman, 2011).

The strategy for the review began by searching for the most relevant literature and then building upon this as the research developed and as new sources were found. The inquirer was supported by a TEC librarian. The TEC library has access to the most advanced information resources. It is accredited by the Southern Association of Colleges and Schools accreditation in the United States. The literature reviewed is drawn from a range of sources, including international academic publications, published research degree theses, conference articles and online materials.

The reconnaissance period of the study identified a tendency for information resources on sustainable design / development to originate in countries outside of Mexico and to be written in English. Therefore, the inquirer decided that it would be important for the research to contribute to filling this gap by developing relevant resources for Spanish speaking people in Mexico and other developing Spanish speaking countries. To respond to this gap, the inquirer interviewed three academics in Higher Education in Mexico. This also enabled the review of literature, in addition to the sources listed above, to draw upon evolving and newly found information.

At the beginning of the study, the literature was selected according to key-word searches and abstracts related to the research topic. The selection of the literature was then informed by the developing findings from the Curriculum Inquiry.

2.2. The structure of the literature review

According to Creswell (2013),

> [s]tudies need to add to the body of literature on a topic, and literature [reviews are] generally shaped from the larger problem to the narrower issue that leads directly into the methods of a study.
> (Creswell, 2013)

As introduced in the previous chapter (p.12), this inquiry addresses the larger problem set by the 'quality education goal' of the government of Mexico's National Development Plan, (PND) and the United Nations Educational, Scientific and Cultural Organization's (UNESCO) agenda on transforming our World: 2030 Agenda for Sustainable Development's (UNESCO, 2017, p.1). The national educational context of the inquiry is investigated through the inquirer's position at TEC, where the reoriented curriculum will be introduced. Within this contextual framework, three interrelated discourses are sourced and discussed. The first discourse concerns the complexity and evolving nature of SD. The second discourse focuses on integrating SD into the curriculum (2.4.2.). The third discourse centres on the geographies and environments within which design functions and interacts. These three discourses provide a research basis for narrowing the focus of the review to the reorientation of the Industrial Design curriculum at TEC. The review of the literature then leads into presenting and discussing starting point themes and markers for the new ESD-centred Design curriculum at TEC; a central element

of which is Competency-Based Education (CBE). CBE is outlined as a general educational development, an initiative at TEC (within the Tec21 Educational Model) and then in relation to the application of competencies in the Curriculum Interventions in Cycle 2, as method of measuring the effectiveness of SD learning and teaching in the interventions. The final section of this chapter (2.7.) presents the main findings from the review. Where relevant, these are linked to findings from the Curriculum Scoping (Cycle 1).

2.3. The complexity and evolving nature of SD

According to the UNESCO, it is important for educators to recognise that 'sustainable development is an evolving concept and that sustainability perspectives can therefore grow and change' (UNESCO, 2012). This organisation also considers that although extensive academic literature exists on the meaning of sustainable development, 'there is no agreed definition of the concept' (UNESCO, 2010). The UNESCO argues that an agreed definition may not be necessary. This is because:

> sustainable development concerns a process of change and is heavily reliant upon local contexts, needs and interests. Thus, sustainable development is an ‘emerging concept’ in two ways, first, because it is relatively new and evolves as we learn to grasp its wide implications for all aspects of our lives, and second, because its meanings emerge and evolve according to local contexts. (UNESCO, 2010)

This Literature Review explores two different paradigms in relation to the Curriculum Inquiry:

- the paradigm for design education; the values and beliefs supporting the ways in which design is taught and
- the paradigm of action research; the beliefs underpinning the ways in which the research is undertaken

For Guba & Lincoln, referring to research paradigms:

> [p]aradigms are axiomatic systems characterized essentially by their differing sets of assumptions about the phenomena into which they are designed to inquire.
> (Guba & Lincoln, 1982, p.233)

Stebbing and Tischner, in relation to design education, propose that the ‘old design paradigm [...] contributed to [...] unsustainable attitudes, wasteful practices and pandering to a throw-away-society' (Stebbing & Tischner, 2015, p.24). For Stebbing, the 'old paradigm' was connected to 'neo-liberal capitalism economics and eco-depleting consumerism' and by comparison, the 'new paradigm' concerns 'design for human welfare and a caring Earth stewardship' (Stebbing, 2015, p.10).

Similarly, Anand et al. consider that as SD '[is] a new way to see the world and take action [...], the integration of SD into higher education requires a profound cultural change more than a technical shift' (Anand et al., 2015, p.922). These authors go onto argue that because of the nature and level of this change, that:

> the approach should not only be to target the content but also the pedagogy and the sometimes compartmented disciplinary structure of our institutions,
> (Anand et al., 2015. p.922)

For Anand et al. (2015), this approach to SD in higher education, with an emphasis on cultural change, requires working at a regional level on sustainability projects, as this enables 'students and educators' to work practically on projects in society and 'in possible cases [...] to be able to see sustainable solutions being adopted' (Anand et al., 2015, p.917). Importantly, in the context of extending ESD to environments outside the university campus, these authors also propose that acting educationally at a regional level creates 'an opportunity to meet, network and collaborate with people with a common vision and benefit from peer-review of the integration approach' (Anand et al., 2015, p.917). Informed by Anand et al. (2015), who identify the educational benefits of working on SD projects in society, at a regional level, the inquirer proposes that in the ESD context of this Curriculum Inquiry, sustainability projects, 'beyond the educational institute' provide opportunities to:

- extend ESD actions to wider groups in society (Anand et al., 2015)
- develop collaborative networks (Anand et al, 2015)
- enable all stakeholders in SD to 'peer review' sustainability projects in action, at a regional level, (Anand et al, 2015
- explore interconnecting [real world] local, regional and global contexts in practice (UNESCO, 2012, p.6)

According to Klarin, (2018. p.68):

> the concept of SD is based on the concept of development (socio-economic development in line with ecological constraints), the concept of needs (redistribution of resources to ensure the quality of life for all) and the concept of future generations (the possibility of long-term usage of resources to ensure the necessary quality of life for future generations).
> (Klarin 2018, p.68)

Klarin goes onto explain that the concept of SD 'implies the balance between three pillars of sustainability'; environmental, social and economic sustainability and that the achievement of 'complete' SD is reliant on maintaining a 'balance between [the] three pillars of sustainability' (Klarin, 2018, p.68). This is because:

> while a certain pillar of achieves sustainability, others can become unsustainable, especially when it comes to ecological sustainability, on which the overall capacity of development depends.
> (Klarin, 2018, p.68).

2.3.1. Integrating SD into the curriculum at TEC

The 'Mexican First' report (2016) proposes that the integration of SD into higher education requires fundamental change ('Mexican First' report, 2016). For this thesis, the term fundamental change is used because it translates from English into Spanish in an appropriate way for Spanish speaking communities and relates to the theory of '[t]transformative learning' (Mezirow,

1990, p.5), described by Mezirow as 'the process of effecting educational change in a *frame of reference* (original italics).

Benneworth and Arbo, (2006) as cited in Jongbloed et al. (2008, p.305), propose that higher education, being next to the area of training and research, interacts with other areas (such as industry, culture, territorial development, labour market) and that these areas ‘affect the higher education agenda’ (Jongbloed et al., 2008). For these authors, ‘higher education is in the unique position of being the sector where the various demands [of other areas] are integrated’ (Jongbloed et al., 2008). In this regard, the inquirer argues that the national scope of TEC, with campuses and professional connections located across all the zones of Mexico, enables this inquiry to:

- develop an understanding of the status of ESD in Mexico
- address the problem of improving SD-ESD in Mexico by integrating SD into the Industrial Design curriculum and
- contribute, at national level, to fundamental curriculum change in the discipline of design, involving all stakeholders in SD

According to the UNESCO (2015, p.6), although the '[i]ntegration of the economic, social and environmental dimensions of sustainable development is key to achieving sustainable development [...] there are also many questions as to “how” this integration is to be achieved'. Although these questions concern the integration of the three dimensions of SD, the inquirer considers that the question of "how" is transferable to this inquiry. That is, while the literature demonstrates that the need to integrate SD into Higher Education curricula is generally agreed upon, there is still the question as to how this objective can be achieved. This is an essential question for this inquiry.

> In what ways can innovations in design education, for sustainable development, contribute to developing 'relevant learning objectives and learning contents'; toward achieving 'the quality education goal' of Mexico (PND 2013, p.22)

2.3.2. The geographies and environments within which design and design education functions and interacts

This third discourse begins by situating the inquiry in its local and global contexts. This leads into providing an historical overview of Industrial Design, as a profession in Mexico and the founding and development of Industrial Design as a discipline at TEC. The three discourses combine to provide a basis of knowledge to inform the reorientation of the Industrial Design curriculum at TEC.

2.3.2.1. Interconnected SD and design geographies

According to the UNESCO, 'solutions to local problems can have global consequences' (UNESCO, 2012, p.6). For Fallan and Lees-Maffei (2015), design is 'conditioned by, and in turn informs its global, regional, national and local contexts at once' (Fallan & Lees-Maffei, 2015, p.5). From a design history perspective, Calvera defines a local reality as dependent on 'global actions' and argues, that the interconnections between local and global influences are complex 'because there is a process of adaptation of ideas, aesthetic references, or technological innovation, coming from abroad and, through feedback, results become subtly different (Calvera, 2005, p.380). According to the UNESCO, importing curricula from other countries or regions is unsuited to ESD objectives, as this approach cannot address local goals and social, and economic contexts (UNESCO, 2017, p.42).

The ways in which design geographies are interconnected (Calvera, 2005, p.376; UNESCO, 2012), establishes an important concept for this inquiry. For example, when referring to a student project engaging with a local reality, the concept means that the project will be bound up together by local and global contexts. The inquirer considers that the concept of interconnecting of design geographies, as proposed by Calvera and reinforced by the UNESCO, is relevant to the inquirer's motivation to contribute to the internationalisation of SD learning and teaching (p.26) and to specific objective 2 of the inquiry:

> to engage in and contribute to international communications on design education for sustainable development, based on perspectives drawn from the setting of the inquiry in higher education in Mexico.

2.3.3.2. The development of Industrial Design as a profession and university discipline in Mexico

The design profession in Mexico originated in the late 1960s when the Olympic Games (Mexico, 1968) required Graphic Design to announce the event to the world (Gomez, 2006). Following this period:

> [t]he Mexican economy of the early and mid-seventies was unable to provide enough jobs for its population, so at this point, the Federal Government needed to create other opportunities for those unable to find work.
> (Gomez, 2006, p.2)

This economic context encouraged universities to create new professional programmes of study, including Industrial Design (Gomez, 2006). The main Mexican universities, which offered this programme, used the name of Industrial Design, rather than Product Design.

> By the 1970´s Mexico faced the challenge of offering higher education to a rapidly growing population. In this context, new professional studies appeared in public universities, especially for those outside Mexico City. In general, Industrial Design programmes emerged inside schools of architecture, having these the pedagogical models 'imported' from the Bauhaus, the Modern Movement or Functionalism.
> (Gomez, 2006, p.1).

According to the Autonomous Metropolitan University, in Mexico City, the first step for the recognition of Industrial Design in Mexico was the emergence of the workshops of master craftsmen Carlos Lazo del Pino (UAM, Azcapotzalco, 2017). Based on this source, the emergence of the undergraduate Industrial Design programmes in Mexico started in 1959 with the creation of the School of Industrial Design at the *Universidad Iberoamericana* (UAM, Azcapotzalco, 2017). Ceballos (2018), states that Industrial Design as a profession, as it was associated with the Industrial Revolution, was first established in countries with a greater technological development than in Mexico, which demanded the process of industrialisation and a new system of production of consumer goods in series. Ceballos identifies that the year of 1990 was a key point for design in Mexico.

> Industrial Design in Mexico enters an intensive stage of creativity, in which educational and research institutions, promotion centres and the media offer a very stimulating panorama such as consequence of the creative work of the new generation of designers, who manage to develop and obtain Mexican design products, designed through the productive possibilities of our country being 100% functional. (Ceballos, 2018, p.1)

In general, Ceballos's narrative of Design in Mexico reflects the industrial production context of design, fulfilling 'the function of making a product more attractive to the consumer' (Ceballos, 2018, p.1).

2.3.3.3. The founding and development of Industrial Design at TEC

The Architecture undergraduate programme at Tecnologico de Monterrey was founded in 1947 and was one of the University's first programmes of study. Although Design programmes often originated in schools of Architecture, it was not until the year 2000 that the discipline of Industrial Design was introduced at TEC.

At that time, only two other universities had Industrial Design programmes:

- *Universidad Iberoamericana*;
- *Universidad Nacional Autónoma de México*.

The undergraduate Industrial Design programme at TEC seeks to educate professionals who are:

- able to work designing and developing new products, services and user-centred experiences within different industrial sectors such as: furniture, crafts, fashion, automotive, electronics and others
- strategists capable of transforming organizations orienting them towards innovation of value through processes based on design thinking, in both companies of goods and services, as in the government and the organizations oriented to the social and environmental innovation
- able to contribute to the inside of the organizations, as independent external consultants or as entrepreneurs through their own company based on design (Tecnologico de Monterrey, 2016)

In August 2016, the inquirer interviewed Haaz, the founder and first Director of the Industrial Design programme at TEC, to investigate the background to the origins of the programme. The interview with Haaz provided first-hand insights into the development of the Industrial Design programme at TEC.

Haaz reported that a student survey in the School of Architecture found that many of the students had decided to study Architecture because they wanted to study at TEC. However, the survey also found that the students had originally wanted to study Industrial Design (Haaz, 2016). Based on this finding, Haaz visited universities to research curricula toward the creation of an Industrial Design programme at TEC. He visited the Polytechnic University of Valencia, the Polytechnic of Milano, the University of the Andes in Colombia and the Catholic University of Chile. Haaz explained that ‘from the beginning, the decision was made that the analytical programme would be focused on aesthetic and conceptual design’ and that this was the reason for visiting the above universities, rather than universities in the United States, which are more focused on the manufacturing dimension of the profession (Haaz, 2016).

In the 1990s, the undergraduate Architecture programme expanded at the Monterrey campus, increasing from eight hundred to more than one thousand students, and at that time, the decision was taken by TEC to create the undergraduate Industrial Design programme (Haaz, 2016).

In a subsequent interview with Haaz (January 2020), a discussion on the change from the 'old paradigm [...] to a new paradigm' (Stebbing, 2015), led the inquirer to ask Haaz, for his opinion on the paradigm of the first design Industrial Design curriculum at TEC. His response was that the programme was, in general, oriented to the 'old' paradigm, but elements, which reflect the 'new' paradigm, were also included in the curriculum. These elements aimed to 'explore materials and manufacturing processes to create products for the well-being of humankind' (Haaz, 2020). It is worth noting in this context, that, since the start of the Industrial Design programme, the same curriculum is taken by students across all TEC campuses, which teach this programme. However, approaches to the curriculum are adapted according to the local contexts of the university's campuses and to the projects that the directors bring to their curricula. For example, at the Puebla campus, since August 2017, a new Director is focusing on the innovation of technology-based products, an approach, which reflects the professional context of the zone in which the campus is located as well as the professional and entrepreneurship paradigms of TEC.

In 2016, the inquirer interviewed Iniguez, the national Dean of the School of Architecture, Arts and Design at Tecnologico de Monterrey. Iniguez proposes that design has changed from a focus on product design to a new situation in which:

> 1) in product life-cycle management, new design variables relate to complex systems
> 2) the complexity of the design project demonstrates the inability of the designer to be the only entity that runs the project, and that this opens the way for projects to involve different actors and disciplines, more extensive working groups and a new era of collaborative innovation and that:
> 3) challenges such as sustainability make innovation begin to incorporate this broad and systemic vision that allows the incorporation of many more variables and not just the variable of producing goods' (Iniguez, 2016).

This view of design, integrating a wider and changing range of factors, echoes the viewpoint of Findeli, who compares the traditional Product Design method, by which a problem is identified, and a final solution is imagined, to a 'state 1 and state 2 of the system and a systematic questioning of the design brief' (Findeli, 2000).

Based on the design project functioning within 'complex systems' and the need for a systemic approach to design to address the challenges of sustainability (Findeli, 2000; Iniguez, 2016; Stebbing, 2015), the inquirer believes that the reoriented Design curriculum requires a systemic approach, which can incorporate a range of methods, including multidisciplinary working groups and collaborative innovation. This is discussed further in the section below, 2.4.3., (p.65).

As highlighted earlier (p.18), the reorientation of the curriculum requires the participation all stakeholders in SD, as this enables different groups in society to contribute to the development of the curriculum, as the subject evolves. Therefore, the inquirer proposes that a systemic approach to the curriculum, incorporating the interests and efforts of all stakeholders in SD, is best suited to achieving the research objectives.

2.4. The reorientation of the Industrial Design curriculum at TEC

This section narrows the focus of the Literature Review to the objectives of the inquiry: the integration of SD into the curriculum and into TEC's continuing educational initiatives. Informed by and extending the three discourses discussed so far, it seeks to provide a research-based justification for the new SD-centred Design curriculum at TEC. As introduced earlier (p.35), the introduction of Competency-Based Education (CBE) at TEC provided an important method of measuring the effectiveness of SD learning and teaching in the Curriculum Interventions. The background to this development at TEC, including the formulation of specific SD competencies, for the Curriculum Interventions and more generally in relation to the ESD objectives of the inquiry, is outlined below (2.4.2.).

Informed by the findings from the review of the literature on the interrelating design, SD and ESD discourses, the following four sub-sections (2.4.1 to 2.4.5.) present themes and markers, as starting points, for the reoriented curriculum. The first section (2.4.1) focuses on the integration of SD into the Industrial Design curriculum, informed by the theme of a systemic curriculum. It also introduces the system of CBE as a central feature of TEC's planned new curricula and in relation to the Industrial Design Curriculum Inquiry. This then leads into outlining the theme of a practical and collaborative curriculum (2.4.2.), how innovative learning methods can support the curriculum (2.4.3.)

and the importance, in the context of fundamental change, of promoting students' 'higher-order' thinking processes (Mezirow, 1990, p.2) - (2.4.4).

2.4.1. The integration of SD into the curriculum to create a systemic approach to ESD

The editors of 'Changing Design Paradigms: Designing for a Sustainable Future', Stebbing and Tischner (2015) assert that sustainability cannot be taught as an ‘add on module to the curriculum’, nor can it be an option, as an independent subject (Stebbing & Tischner, 2015, p.3). For these authors, sustainability must ‘permeate the entire curriculum as it does our lives’ [as] 'to live sustainably' concerns an 'attitude of mind', more than 'a mere collection of facts learnt today and possibly forgotten tomorrow’ (Stebbing & Tischner, 2015, p.3). This argument, that SD must be transversal in the curriculum and that SD learning should involve personal engagement, contributes to developing an important research basis, the theme of a systemic curriculum, for the reorientation of the Industrial Design curriculum.

Tischner, (2001), suggests that there is a lack of tools developed specifically for sustainable design (Tischner, 2001). Other authors propose checklists and guidelines for Product Design students. For example, Luttropp and Lagerstedt (2006) propose 'ten golden rules' and Edwards (2005) promotes the linking of design to the environmental impacts of the life cycle of products, and to the social aspects of manufacture (Edwards, 2005, p.2). In this context of providing tools, guidelines and rules for sustainable design / education, the Curriculum Interventions introduce the use of competencies for the first time at TEC.

Through the formulation and implementation of specific SD competencies the inquirer proposes that they should:

- enable the evaluation of students' learning to explicitly encompass personal development and
- encourage deeper learning by better enabling the students to interpret knowledge content through their design projects.

Kemmis and Fitzclarence (1991 cited in Leask, 2008), propose encompassing 'all aspects of the learning/teaching situation' in a curriculum (Leask, 2008, p.12). According to Leask, this approach is 'inclusive of content, pedagogy, assessment and competencies; planned and unplanned experiences (Leask, 2008, p.12). Similarly, Stebbing and Tischner (2015) challenge educators to 'stimulate the greening of educational institutions as examples of practicing sustainability' (Stebbing & Tischner, 2015).

Informed by the review of the literature, the inquirer proposes that the reoriented Industrial Design curriculum should provide, as interdependent elements within a systemic curriculum:

- SD content, learning and teaching methods and approaches and
- the practice of sustainability through experiential learning.

The inquirer believes that this approach enables students to be more engaged in problem-based design projects, for example by working on projects inside and outside the campus, with communities and companies.

2.4.1.1. Competency-Based Education in relation to Higher Education

This section provides an overview of competency-based education (CBE). This leads into the development of CBE at TEC and the formulation and use of

SD competencies in the Curriculum Interventions and more generally in relation to the Design ESD objectives of the inquiry.

> Competency-Based Education is a learning method that has changed the traditional teaching-based focus to a learning-based one. Students are the centre of the process, in which they must learn to learn, solve problems, and adapt to changes in their environment. The goal is to provide learning based on knowledge, skills (know-how), attitude and behaviour. These sets of knowledge are called competencies. (Ochoa C. et al., 2015).

In 1994, the government of Mexico's Project for the Modernization of Technical Education and Training, established an official policy related to CBE in vocational training. In 1995, the 'Council for Standardization and Certification of Labor Competence' (CONOCER) was founded. Based on a model from England, this organisation included representatives of private and social sectors, and members of the public. In 2004, the educational model of the Technological Universities of Mexico was implemented. This responded to the needs of the country's different productive sectors and society.

Established in 2000, the 'Educational Structures in Europe Project (Tuning)' initiative was 'aligned with a development in the preceding decade' (Wagenaar, 2014). This development was regarded as a 'new paradigm for undergraduate education' (Barr & Tagg, 1995 cited in Wagenaar, 2014). Barr and Tagg observed 'a shift taking place in US colleges from the former emphasis on *providing instruction* to *producing learning'* (Barr & Tagg, 1995 cited in Wagenaar, 2014).

The Tuning 'initiative was based on assumptions formulated as educational challenges' (Wagenaar, 2014), two of which converge with other findings from the review of the literature and are viewed by the inquirer as critical to the social and professional demands of this ESD-based inquiry.

> Higher education structures and programmes and qualifications should be reformed on a large scale to be able to respond to the needs of society, to be understood in terms of preparing for employability and citizenship.
> (Barr & Tagg, 1995 cited in Wagenaar, 2014)

This encompassing of higher education 'structures and programmes and qualifications', aligns with the concept of a systemic curriculum and the assertion that improving Design ESD in Mexico requires the participation all stakeholders in SD, allowing different groups in society to engage in generating the curriculum (pp.19-39).

> All stakeholders, including (potential) employers and professional organisations, but in particular graduates should be (indirectly) involved in the process of curriculum design and quality enhancement.
> (Barr & Tagg, 1995 cited in Wagenaar, 2014).

Although this imperative focuses on curriculum design, quality enhancement and the role of graduates, the demand for employers and professional organisations to be involved in curriculum development resonates with the proposal (p.37) that sustainability projects, 'beyond the educational institute' opens opportunities for wider groups of society to participate in and see sustainability projects in action (Anand et al, 2015).

2.4.1.2. Interconnections between CBE, experiential learning, action research and Design ESD

According to Turcio and Palacios, the use of competencies is suited to practical learning experiences as their results can be demonstrated and measured according to the activities of a profession (Turcio & Palacios, 2015). With a similar emphasis, Guzman, proposes that competencies promote 'the development of a set knowledge, skills and attitudes' and that this 'allows the learner to acquire integral and relevant skills for their professional work' (Guzman 2003, p.145). This relationship between CBE and professional work is aligned to the professional context of TEC and provides an important justification for the development of the five SD competencies for the new Design curriculum. For Guzman, definitions of CBE have two positions, one considers competencies from an academic perspective and the other from the labour point of view (Guzman, 2003, p.9). According to the first position, competencies are described as:

> [a] type of expression that makes it possible to collaborate and participate in the development of tasks focused on the maturation of the individual and the execution of various roles that he / she has to perform in life, as an apprentice, as a producer of goods and services, as a consumer and as a member of social units.
> (De Anda, 1997, cited in De Guzman, 2003, p.9).

Guzman's second position, which focuses on professional and workplace contexts, is the most accepted worldwide (Guzman, 2003, p.2).

> The CBE is an educational modality that allows educating the learner based on labour or professional competency standards obtained from the requirements of the productive sector and services. Its teaching methodology emphasises know-how and uses an organisation and infrastructure similar to those in the workplace to deploy these skills (Guzman, 2003).

Compared to Guzman's broader first 'position' of CBE, the emphasis of the author's second 'position' connects competencies, developed by learners in formal education, to those required in the workplace. The inquirer proposes that the combination of these positions, encompassing life, study and the workplace represents a holistic educational approach.

The inquirer considers that the literature reviewed on CBE and ELT contributes to formulating critical pedagogies for this inquiry. In particular, the holistic nature of these educational models aligns with the interdependent goals of SD (Klarin, 2018, p.67; Griggs, et al., 2014), as referenced earlier (pp.13-14). The inquirer proposes that this alignment creates a coherent educational framework because it embraces different learning styles, approaches and the stages of 'growth and development' that an individual experiences, as a student, professional and citizen (Kolb, 1981, p.235; Turcio & Palacios, 2015; Guzman, 2003).

> The holistic nature of the learning process means that it operates at all levels of human society from the individual, to the group, to organizations, and to society as a whole.
> (Kolb & Kolb, 2017, p.11).

Swann's paper, 'Action Research and the Practice of Design' (Swann, explores the ways in which action research is relevant to the 'interpretive nature of design' (Swann, 2002, p.50). For Swann, Schon's 'The Reflective Practitioner' is critical to this approach, as:

> Schon formulates an epistemology of practice based largely on an examination of the way in which practitioners reflect on their actions during and following their work.
> (Swann, 2002, p.50).

Through describing the ways in which reflective practice works, Swann goes on to propose that Schon's text 'intentionally [shows] a relationship [between reflective practice] and the design process (Swann, 2002, p.50).

In a section of 'Creating Design Knowledge: From Research into Practice' (2000), which concerns '[e]xperiential and reflective knowledge', Friedman affirms the nature of the design process and design knowledge.

> The design process is rooted in and involves both theoretical disciplines and fields of practice. As all fields of practice do, design knowledge involves explicit knowledge and tacit knowledge.
> (Friedman, 2000, p.42)

Friedman relates the consensus viewpoint that 'knowledge creation requires experience' to Kolb's perspective of learning as a 'process through which knowledge is created through the transformation of experience' (Kolb, 1981, cited in Friedman, 2000, p.42).

The inquirer considers that the connections between:

- action research, 'as a program for change in a social situation and the 'interpretive nature of design' (Swann, 2002, p.50) and
- the creation of knowledge and 'through the transformation of experience' (Kolb, 1981, cited in Friedman, 2000, p.42),

provides an important educational theoretical framework for the new SD-centred Industrial Design curriculum at TEC.

Through investigating 'effective methods for teaching sustainability within product design, in British and Irish Universities', Watkins, (in his Doctoral Thesis titled “An investigation into effective methods for teaching social sustainability within product design in British and Irish Universities”, Loughborough University) identified that a lack of engagement existed regarding the 'social aspects' of the discipline and therefore the need for the study to explore how to address this gap (Watkins, 2013). The study involved interviews with a sample of academics 'in the field of sustainable design education'. The academics were invited to consider important learning and teaching methods and approaches for sustainable product design (Watkins, p.112). The majority of the academics proposed methods, such as 'directed field trips [and] working with 'external clients', which encourage 'deep learning, including experiential learning and immersive learning opportunities and techniques' (Watkins, p.112). It is important to highlight that the experts' responses were in the context of addressing the lack of engagement of Product Design education in the social dimension of ESD. This finding supports the argument, developed through this Literature Review, that a

Design ESD should involve actions in organisations and the whole of society (pp.37-47-51).

The review of the literature on CBE, ELT, action research and the design process justifies the importance of these theories and practices in relation to the reorientation of the Industrial Design curriculum. In particular, the inquirer considers that the literature reviewed supports the way in which this inquiry explores aspects of educational and design theory through practical methods, involving collaborative, participatory and multidisciplinary activities.

2.4.1.3. The development of CBE at TEC

EduTrends is a digital magazine published by TEC. The EduTrends report published in February 2015 was dedicated to CBE. It reported that the concept of competency in education appeared in the 1970s, in response to the inadequate relationship that existed at that time between education programmes and the needs of the labour market (EduTrends, 2015, p.10). The report proposed that CBE articulates learning objectives, demonstrating the acquisition of a set of 'skills, values and attitudes' (EduTrends, 2015, p.10).

As introduced in Chapter 1 (p.18), the Tec21 Educational Model establishes principles and guidelines for the design of the new curricula at TEC, one of which is the system of CBE. Garza, who is the Rector of Tecnologico de Monterrey, proposes that the Tec21 Educational Model, which was informed by research conducted across over forty universities worldwide, aims to 'effectively prepare students not only to get a job but to contribute to the development of their community and the world' (Garza, 2019). In this regard, as highlighted above, the University's introduction of CBE connects to its professional paradigm. TEC also believed that the implementation of CBE would redefine its learning assessment system (Edutrends, 2015) and align the renewal of the University's curricula to worldwide developments in higher

education. The Tec21 Educational Model states that 'the evaluation focuses on the development of student competencies that make up their graduation profile' and the achievement of these 'at key moments of their academic life' is observed (EduTrends, 2015). It is worth noting that '[o]ne of the basic requirements of the Tec21 Education Model is to engage students in problem-based learning, utilizing modern technological tools for the greatest social impact and community benefit' (Tec21, 2019 cited in Krstikj, 2020).

The inquirer considers that this interpretation aligns CBE with Kolb's influential theory of experiential learning.

> The experiential learning model represents an integration of many of the intensive lines of research on cognitive development and cognitive style. The result is a model of the learning process that is consistent with the structure of human cognition and the stages of human growth and development.
> (Kolb, 1981, p.235)

A more recent examination of experiential learning theory (ELT) and its application in Higher Education describes ELT as a 'holistic theory of the process of learning from experience and a multi-dimensional model of adult development' (Kolb & Kolb, 2017, p.11). For these authors, the theory involves the 'whole person' in the learning and adapting process and applies to any learning environment; 'in all arenas of life' (Kolb & Kolb, 2017, p.11).

2.4.1.5. The timing of CBE at TEC in relation to the Curriculum Inquiry

Before TEC introduced CBE, the University's curricula focused on a more knowledge-based pedagogy with students' work being assessed according to learning objectives. The University found that this approach tended to encourage the students to perceive their learning too narrowly on acquiring the knowledge required to pass their courses and that:

- CBE helps to create a more active, functional and comprehensive approach to learning, and that:
- CBE is better suited to enabling the students to link their learning experiences, encompassing knowledge, skills, values and attitudes, to real-world (professional and work) challenges

The teaching of the new university-wide curricula at TEC started in August 2019, from the start of the Fall semester. Therefore, the application of the Curriculum Interventions, which integrated SD competencies into the Project courses of the Design and Architecture curricula, was undertaken before the implementation of the University's new curricula, including the use of competencies.

As described above, a set of five SD competencies were formulated to support the Curriculum Interventions and to test their use by students, in advance of TEC's formal introduction of CBE and the implementation of SD competencies in the new Industrial Design curriculum. The inquirer expects that the competencies will need be adjusted and / or renewed over time, as sustainable design and ESD evolves, and proposes therefore that fundamental curriculum change must be supported by incremental development.

2.4.1.6. CBE in relation to the Design ESD objectives of the Curriculum Inquiry

The introduction of the system of CBE at TEC meant that the inquiry could be aligned to this university-wide educational initiative and test the implementation of competencies, as a SD-centred learning and teaching method and as a quantitative research method of measuring the effectiveness of including SD content and learning and teaching methods in the Curriculum Interventions.

As identified earlier (p.36), the integration of SD into higher education requires 'a profound cultural change' (Anand et al., 2015) and a systemic approach, encompassing 'content, pedagogy, assessment and competencies; planned and unplanned experiences (Leask, 2008). Similarly, Anand et al. consider that as SD '[is] a new way to see the world and take action, [...] the integration of SD into higher education requires a profound cultural change more than a technical shift' (Anand et al., 2015, p.922). These perspectives reflect the inquirer's expectation that fundamental curriculum change would be needed to reorientate the Industrial Design curriculum (p.18). In this context of curriculum change, the introduction of CBE at TEC, provided this Curriculum Inquiry with an important method of exploring the research question:

> how innovations in design education, for sustainable development, can contribute to developing 'relevant learning objectives and learning contents'; toward achieving 'the quality education goal' of Mexico (PND 2013).

It is important to reiterate that TEC's process of formulating generic competencies, through the Tec21 Educational Model, was proceeding during the inquiry and that within this educational development, the inquiry informed the formulation of specific SD competencies to be applied and tested through the Curriculum Interventions in Cycle 2. This contributed to developing an

understanding of the ways in which a learning-based educational paradigm could inform the creation of relevant SD learning and teaching methods and approaches. Chapter 4 (p.136) presents the results of the testing of the application of the SD competencies through the Curriculum Interventions (Cycle 2).

With a focus on education for sustainable consumption (ESC) and reflecting on the transition from learning focused on a 'knowledge-based to a primarily competence-based approach', Frank and Stanszus, (2019), propose two approaches to learning that:

> allow students to systematically acquire personal competencies for sustainable development in general and sustainable consumption in particular: self-inquiry-based learning and self-experience-based learning.
> (Frank & Stanszus, 2019)

This focus on personal development competencies informed the formulation of Competency #2. This competency concerns the development of students' personal learning development, as demonstrated through their successful application of the principles of SD to their projects. According to Limeri et al., 2020:

> [t]he extent to which students view their intelligence as improvable (i.e., their “mindset”) influences students’ thoughts, behaviors, and ultimately their academic success.
> (Limeri et al., 2020)

These authors argue that in addition to students' 'academic success [being] influenced by their cognitive abilities and content knowledge', their success is also dependent on their 'non-cognitive' abilities; 'such as their beliefs, attitudes, and values' (Limeri et al., 2020). According to Dweck et al. (1999 cited in Limeri et al., 2020):

> Students who believe that intelligence is a stable, unchangeable trait are described as holding a "fixed mindset" and are likely to interpret struggle or failure as an indication that they are not intellectually capable of succeeding.
> (Dweck et al., 1999 cited in Limeri et al., 2020, pp.1-2)

By comparison, 'students who believe that intelligence is a changeable [characteristic and improvable], are described as holding a "growth mindset" [and] are more likely to take on challenging tasks' (Dweck et al., 1999 cited in Limeri et al., 2020, pp.1-2). This comparison between 'fixed' and 'growth' mindsets is relevant to this inquiry in two ways. It indicates the need for the curriculum to promote experimentation and risk taking, to support students in exploring the challenges of sustainability (p. 46) and to encourage students as their learning experiences grow and evolve. The justification for Competency #2 is discussed further on the next page.

The inquirer believes that the use of transversal and disciplinary competencies is better suited to the challenges of design education for sustainable development, than the more teaching-based learning objectives (Klarin, (2018, p.1). This view is similarly advanced by Weinert (2001 cited in Frank & Stanszus, 2019, p.2), who highlights that the 'system allows individuals to deal with complex demands in specific real-life situations' and that competencies can be formulated to encourage students to acquire interconnected 'cognitive,

emotional, and motivational' competencies (Hartig et al., 2007 cited in Frank & Stanszus, 2019, p.2).

The review of the literature on Competency-Based Education identified two significant findings for the Curriculum Interventions and the new Design curriculum:

1. CBE enables the promotion and evaluation of SD learning and teaching
2. Specific SD-oriented competencies can be formulated, focused on knowledge content, cognitive processes, and personal development (attitudes and beliefs), informed by ESD research and development.

The discussion above has outlined the relationship between CBE (within the Tec 21 Educational Model) and the Curriculum Inquiry. In this way, the adoption by TEC of CBE provided a context, at a strategic university-wide level, for the creation and testing of SD competencies as an important method for the Curriculum Interventions. Each of the five SD competencies are discussed and justified, in relation to curriculum themes, in the sections below, 2.4.2. to 2.5.4.

The proposal that competencies encourage students' development of a set of interrelated knowledge, skills and attitudes' (Guzman, 2003, p.144), influenced the formulation of three of the five SD competencies:

Competency #1: the development of SD knowledge.

> The student´s work demonstrates knowledge and understanding of SD locally/globally.

The literature found that SD learning involves the exploration and interpretation of knowledge content, (p.49) and that the process of reflection can lead to 'new understandings' (Boud et al., 1985, p.3).

Competency #2: the students' personal learning development

> The student’s work demonstrates a mindset change in relation to SD through the successful application of SD principles to her/his projects as well as in her/his own lifestyle.

This competency connects a student's personal learning development to the application of SD principles, inside and outside disciplinary learning situations. The inquirer proposes that this approach to SD learning enables the student to see that her/his design projects and experiences outside the university are interconnected and therefore, that learning and personal development are also interconnected.

Competency #3: critical skills applied to projects.

> The student assesses the life cycle of the product/s of her/his projects based on criteria that relate to the minimisation of the multiple environmental impacts throughout the cycle.

The review of the literature on educational methods, relevant to ESD, includes discussion on collaborative innovation in the context of the social dimension of SD. This is discussed below in relation to how the findings from the review of the literature on this topic contributed to informing the formulation of Competency #4 (pp.60-61-62). This topic is then related to multidisciplinary and collaborative SD learning methods, in the context of social innovation and the development of Competency #5 (pp.68-68).

The set of five competencies are presented and discussed in relation to their implementation in the Curriculum Interventions in Chapter 4 (p.138).

2.4.2. A practical and collaborative curriculum

Cosme et al., (2018), in relation to engineering education and with a focus on life cycle assessment (LCA), propose a curriculum structure, comprising 'a combination of theoretical teaching, practical assignments and hands-on practice on LCA case studies, and [...] collaboration with companies or other organisations' (Cosme et al., 2018, p.1). This combination of practice and theory connects to the argument that all stakeholders should be 'involved in the process of curriculum design and quality enhancement (Barr & Tagg, 1995 cited in Wagenaar, 2014) and is applicable to this inquiry as it supports ESD collaboration with external organisations. In this regard, the inquirer proposes that the application of theory to real-world projects is critical to supporting the participation of all stakeholders in SD.

According to Benneworth and Arbo (2006) as cited in Jongbloed et al. (2008, p.305), ‘higher education is in the unique position of being the sector where the various demands [of other areas] are integrated’ (Jongbloed et al., 2008, p.305). As identified above (p.37), for Anand et al. (2015) projects beyond the university can involve a broader range of participants in design projects than the traditional 'classroom' model; enable participants in projects to experience and review SD initiatives in practice, at a regional level and create opportunities for different SD actors to develop collaborative networks. Similarly (p.37), projects in different locations can create opportunities to explore the interconnections between local, regional, national and global contexts (UNESCO, 2012).

It is worth noting here, that the focus on collaborative practice with industry were an inspiration for the formulation of the Competencies #1 and #3.

2.4.3. Encouraging social and collaborative innovation

The Government of Mexico's asserts that 'educational innovation requires education spaces with access to new information technologies and communication' (Government of Mexico PND, 2013) and according to the government's Ministry of Education, an innovative learning and teaching environment ‘is capable of evolving and adapting as educational practices evolve and change' (Government of Mexico, Ministry of Education, 2014). As identified in the previous chapter (p.25), based on her teaching at TEC, the inquirer observed how students learn more effectively in learning environments where traditional and digital technologies and methods are combined. This observation, which is aligned to the Government of Mexico's educational goals, together the inquirer's growing interest in improving social design education in Mexico (p.25), provided important motivations behind this Curriculum Inquiry.

Concurrent to this inquiry, a professor in the School of Architecture, Art and Design at TEC, undertook a research project centred on social innovation. The project was applied to the undergraduate architectural studio course at TEC's Mexico State campus in the municipality of Atizapán de Zaragoza (Krstikj 2021, p.10). The project proposed a 'collaborative educational method' (Krstikj 2021, p.2) to encourage 'social innovation in placemaking' (Krstikj 2021, p.18). Krstikj situates the research in the context of problem-based learning and service-learning (Jocoby et al., 1996 cited in Krstikj, 2021, p.3). According to Astin et al., studies have consistently shown that students' 'learning, critical thinking, and personal growth are enhanced by service' (2000, cited in Krstikj, 2021, p.3). Krstikj highlights that a study undertaken by Blakey et al., involving the engagement of teachers with service-learning, resulted in 'a large majority' of the teachers reporting that they were 'also learning alongside students' (Blakey et al., 2015, cited in Krstikj, 2021, p.3).

As highlighted above (p.64), the higher education sector is able to integrate 'the various demands [of other areas] (Benneworth & Arbo, 2006 cited in Jongbloed et al., 2008, p.305) and 'the complexity of the design project' involves 'more extensive working groups and a new era of collaborative innovation' (Iniguez, 2016). The process of integrating different areas, inside and outside universities, requires communication. For Stebbing, 'communication/digital technologies offer exciting possibilities for new sustainable and social infrastructures and the potential for maximizing cooperation' (Stebbing, 2015, p.10). One of the specific objectives of this inquiry is to create innovative learning methods and develop an understanding of how they can contribute to integrating SD into the Industrial Design curriculum at TEC (p.25). Chapter 5 provides information on the development of the online SD learning space (Sostek). The findings from the review of the literature on collaborative and social innovation and the 'process of integrating different areas, inside and outside universities', as discussed above, informed the development of the online learning space for the reoriented curriculum. This initiative provides a method, which can support the students' development of three of the competencies.

Competency #1: the development of SD knowledge.

> The student´s work demonstrates knowledge and understanding of SD locally/globally.

Competency #3: critical skills applied to projects.

> The student assesses the life cycle of the product/s of her/his projects based on criteria that relate to the minimisation of the multiple environmental impacts throughout the cycle.

Competency #4:

> The student encourages the rest of the group´s involvement in SD when presenting her/his projects to the group.

2.4.4. Reflective learning supporting fundamental curriculum change

The International Higher Education Teaching and Learning Association (2018) challenged universities to:

> develop students' ability to appreciate the complexities of sustainability and translate their knowledge into systemic, anticipatory and critical thinking ability.
> (International Higher Education Teaching and Learning Association, 2018).

As discussed earlier (p.57), '[o]ne of the basic requirements of the Tec21 Education Model [was] to engage students in problem-based learning [...] for the greatest social impact and community benefit' (Tec21, 2019 cited in Krstikj, 2020). Therefore, this renewed educational approach, supported by CBE, requires that TEC's curricula encourages the development within students' 'higher-order' skills (Mezirow,1990).

According to Mezirow (1990, p.2), learning 'involves making new interpretations', enabling learners to either 'reinforce [...] long-established frames of reference or to create new meaning schemes'. Mezirow suggests that 'the process of reflecting back on prior learning to determine whether what we have learned is justified under present circumstances' is possibly more important than giving attention to 'established meaning schemes' (Mezirow,

1990, p.2). For Mezirow, reflection, as a 'higher-order learning process' (Mezirow, 1990, p.2) enables learners to explore 'new understandings and appreciation' (Boud et al., 1985, p.3., cited in Mezirow, 1990, p.2).

As introduced in Chapter 1 (p.38), the inquirer considers that Mezirow's concept of 'transformative learning [as] the process of effecting change in a *frame of reference'* (italics in original) - (Mezirow, 1997) relates to the use of the term fundamental change for this thesis. In this context, it is important to highlight that Mezirow considers that, rather than holding a fixed frame of reference, '[w]hen circumstances permit':

> transformative learners move toward a frame of reference that is more inclusive, discriminating, self-reflective, and integrative of experience.
> (Mezirow, 1997, p.3)

De Haan (2010 cited in UNESCO, 2017), identifies competencies, which are 'generally seen as crucial to advance sustainable development' (UNESCO, 2017, p.10). These are linked to the complexity of systems and the uncertainty of SD and identify critical, self-reflection and problem-solving competencies. For Limeri et al., who refer to 'growing growth mindsets' (Dweck et al., 1999 cited in Limeri et al., 2020, pp.1-2),

> [s]tudents' academic success is influenced not only by their cognitive abilities and content knowledge, but also by non-cognitive factors, such as their beliefs, attitudes, and values.
> (Limeri et al. (2020, p.1)

Informed by the literature on critical reflection as a 'higher-order learning process', the inquirer considers that the process of developing 'new understandings', through developing reflective practice processes, is critical to Design ESD, as both sustainable development (De Haan, 2010) and the design project (Iniguez, 2017) are complex and evolving subjects (Iniguez, 2017, p.37). Therefore, an important marker for the reoriented SD-centred curriculum is that reflective learning, applied to practical projects, is essential to improving students' SD learning. This approach is linked also to Competency #2.

2.5. The main findings from the Literature Review on approaches to the reorientation of the Industrial Design curriculum at TEC

As highlighted above (p.59), although the integration of sustainability into higher education curricula is generally accepted as a necessary and urgent goal there is still the need to explore how this goal can be achieved (UNESCO, 2017, p.6). This emphasis on developing an understanding of 'how' to integrate SD into the curricula, reflects the research question of this inquiry.

> In what ways can innovations in design education, for sustainable development, contribute to developing 'relevant learning objectives and learning contents'; toward achieving 'the quality education goal' of Mexico (PND 2013, p.22)

The review of the selected literature, in conjunction with findings from the Curriculum Scoping, provide a research-based justification for the following framework of themes and markers for the new Design curriculum.

2.5.1. Fundamental-incremental change

The review of the literature contributed to developing an understanding of the level of change required to integrate SD into Industrial Design curriculum (p.38). The literature informed the inquirer's selection of practitioner-led action inquiry methods (p.12) and an approach to fundamental curriculum change, supported by incremental development. In particular, the inquirer identified that this approach would allow the study to respond to emerging findings from the Literature Review and the Curriculum Inquiry.

For example:

- a conversation between the inquirer and a professor, in preparation for the Curriculum Interventions, resulted in the professor adjusting the curriculum (a Project course) and
- the use of SD competencies in the Curriculum Interventions (Cycle 2) led to adjusting four of the five the competencies

2.5.2. A systemic approach to the curriculum

The review of the literature has discussed why the challenges of the design project and sustainability demand a systemic approach to the curriculum (Findeli, 2000; Iniguez, 2016; Leask, 2008; 2016; Stebbing, 2015). According to this theme, the findings from the review, contributed to consolidating three interrelated markers for the reoriented Industrial Design curriculum:

1. The curriculum encompassing knowledge content, pedagogy and different environments
2. ESD acting beyond the University campus and
3. Real-world design problems and contexts encompassing problem-based learning

2.5.2.1. SD learning encompassing knowledge content, pedagogy, assessment and competencies (Leask, 2008)

As highlighted above (p.49) Leask proposes encompassing content, pedagogy, assessment and competencies; planned and unplanned experiences in a curriculum (Leask, 2008, p.12). This enables students to engage in a variety of learning/teaching situations (Leask, 2008). The inquirer suggests that this approach also encourages students to explore different and changing interpretations of knowledge content through their design projects (Ryan & Tilbury, 2013, p.5).

2.5.2.2. ESD acting in environments beyond the university

This section presents the importance of ESD acting in environments beyond the university and the need for universities to work collaboratively with others, to address SD-ESD problems. The findings from the Literature Review highlighted that the more universities work to increase their efforts to support SD in society, the more SD in society can support ESD (Haaz, 2016). As outlined above (p.39), a collaborative vision for the curriculum (Cosme et al., 2018; Jongbloed et al., 2008, p.305) is aligned with the need for the research to lead to firmly integrate SD in the curriculum. For the inquirer, a significant benefit of developing collaborative networks is that it creates opportunities for all stakeholders in SD to see and/or participate in contributing to sustainability projects in practice and enables students to experience the curriculum working outside the classroom. In this way, the literature contributes to informing what the inquirer believes to be an essential social-environmental basis for the creation of a systemic SD-centred curriculum.

2.5.2.3. ESD and problem-based learning

The literature highlighted that developing approaches to real-world design problems and contexts (Jacoby et al., 1996 cited in Krstikj, 2021, p.3), consider that service-learning connects community service to 'problem-based learning' (Jacoby et al., 1996). This influenced the formulation of the competencies, in particular Competency #1:

Competency #1:

> The student´s work demonstrates knowledge and understanding of SD, locally/globally.

2.5.3. Encouraging multidisciplinary and collaborative social innovation

As described above (pp.57-65), the review of the literature on social innovation and 'collaborative educational methods' (Krstikj, 2021; Iniguez, 2016; Stebbing, 2015, p.10) contributed to informing the creation of an online learning space. The development of this method involved collaboration between a multidisciplinary working group of professors and an interdisciplinary group of students (Architecture and Industrial Design). Based on the inquirer's experience of leading this project and observing the participants' active engagement in developing the instruments of the space, the inquirer recognised how the project gathered a positive momentum, as new possibilities emerged. Therefore, the inquirer proposes that the SD online learning space reflects how such a project can encourage 'more extensive working groups and a new era of collaborative innovation' (Iniguez, 2016) and that the project contributes to answering the research question: Why is the creation of innovative learning approaches of critical importance to SD in Mexico?

Two of the five SD competencies formulated for the Curriculum Interventions promote multidisciplinary and collaborative approaches to SD learning. The inquirer found that the literature contributed importantly to developing a broader and deeper understanding, as outlined above (p.59), of the ways in which social and collaborative innovations can be integrated into the curriculum, aligned to the students' development of SD competencies.

> Competency # 4: The student encourages the rest of the group´s involvement in sustainable development when presenting her/his projects to the group.
>
> Competency # 5: The student looks for and finds knowledge inputs and expertise from other disciplines to meet the sustainability requirements that her/his project needs’.

2.5.4. 'Higher-order' thinking processes: developing SD mindsets

The review identified that the development of students' higher-order' competencies is essential to effective SD learning. As identified above (p.67), an important marker for the new SD-centred Design curriculum is the need to encourage the students' reflective and creative engagement in successfully applying SD principles and practices to their projects. As identified above, this finding informed the development of one of the competencies, formulated for the Curriculum Interventions. This competency interconnects the development of reflection to developing 'growth' mindsets (Limeri et al., 2020, p.1). The inquirer argues, aligned with the literature, that reflection in action (Mezirow, 1990, p.2), allied with developing mindsets, fosters deeper engagement in SD learning than the traditional model. (Ryan & Tilbury 2013, p.5).

As discussed above (p.51), the literature contributes to developing an understanding of the interconnection between cognitive processes and developing mindsets. One of the competencies formulated for the Curriculum Interventions was based on the inquirer's perception, from the start of the inquiry, that the reorientation of the curriculum would need to engage students in exploring their beliefs and attitudes through their design projects. The following competency was based on this perception and informed, as the inquiry developed and by the literature on cognitive learning processes and developing mindsets.

Competency #2:

> The student's work demonstrates a mindset change in relation to SD through the successful application of the principles of SD to her/his projects as well as in her/his own lifestyle.

2.6. Further ESD research and communication

This review found that compared to Western literature on Design, SD and ESD, equivalent literature based on perspectives from Mexico is inadequate to supporting the sustainable development of the country. Although this review of literature has focused on informing the development of the Design curriculum in a national university, in Mexico, it has also, necessarily, explored how local, regional and global contexts are interconnected. The inquirer believes that the outcomes of this study, undertaken in and focused on a national context, demonstrate the potential to counterbalance the prevalence of Western perspectives and at the same time, to contribute to Western and wider international dialogues and proposals.

2.7. Adjusting the original research question

The drivers and contexts for the curriculum change were:

- The inquirer's interest in and motivation to develop innovative learning methods and social design projects (p.26)
- The UNESCO (2012) document, asking universities to reorient their curricula to achieve ‘new skills, values and attitudes that lead to more sustainable societies’ (UNESCO, 2017, p.1)
- The Government of Mexico’s (PND) quality education agenda, to support 'sustainable economic and social progress’ (p.15)

In addition to these drivers and contexts, concurrent with this case study, TEC, was renewing the University's curricula, according to its new educational model (Tec21). As mentioned earlier (p.48), this model incorporated the system of competency-based education for the first time at TEC, representing a core initiative in the renewal of the University's curricula. The adjusted competencies are presented in Chapter 4 (p.155).

The findings from the Literature Review led to adjusting the original research question (Chapter 1., p.30). The original research question (p.30) was:

> In what ways can innovations in Design education, for sustainable development (in higher education), contribute to developing 'relevant learning objectives and learning contents’ towards achieving the 'quality education goal' of Mexico (PND 2013).

The reformulated question is more open than the original question, which identified *innovations* (the inquirer's italics) in sustainable development as a critical feature of the reoriented curriculum.
The review of the literature on the relevant discourses opened different ways of understanding what the findings from the literature could mean for the

inquiry. The second iteration replaces *innovations* with *curriculum change* and refers to research objective 1. The inquirer considered that the specific reference to *innovations* in the original research question was unjustifiably specific, in advance of exploring in more depth and detail, the implications of the research findings.

The second iteration of the research question:

> In what ways can curriculum change, with the objective of integrating relevant sustainable development 'learning objectives and learning contents' into the Industrial Design curriculum, contribute towards achieving the quality education goal of Mexico?

Chapter 3. Research Methodology

3.1. Introduction to the research methodology

> Research approaches are plans and the procedures for research that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation.
> (Creswell, 2014, p.31)

The next section of this chapter presents the paradigm guiding the research design and the development of the specific ‘plans and procedures’ for this action inquiry (Creswell, 2017, p.17). This is followed by sections, which outline the research design (3.3), the organisation and methods of the inquiry (3.4) and the specific set of methods undertaken for each cycle (3.5, 3.6, 3.5.7). The final section of this chapter states the ethical considerations, which the inquirer considered in meeting the requirements of the Birmingham City University Ethical Principles and Practice Policy Statement and their equivalent at TEC.

According to Creswell, 'research seeks to develop relevant, true statements [...], to explain the situation of concern' (Creswell, 2017, p.37). In the case of this inquiry, the situation, which troubled the inquirer, originated from recognising the need for universities in Mexico to increase their efforts to improve ESD (p.10). The research objectives, deriving from this situation are to integrate SD into the Industrial Design curriculum at TEC and to contribute to integrating SD into the University's developing educational initiatives (p.20). Creswell explains that an inquirer's 'research questions and hypotheses [...] serve to narrow and focus the purpose of the study’ (Creswell, 2014, p.23). As identified in the previous chapter (p.70), the Literature Review informed an

adjustment to the original research question and the addition of two further questions, helping to focus this case study on exploring ways of improving ESD.

The inquirer considers that the following definition of a case study corresponds with how this inquiry is being undertaken over time, alongside the teaching and renewal of a curriculum, and within the context of the investigation.

> Case study research consists of a detailed investigation, often with data collected over a period of time, of phenomena, within their context. (Cassell and Symon, 2004, p.323).

According to Stake, (1995) and Yin, (2009) as cited in Creswell (2013, p.43), case studies 'are bounded by time and activity' and use a 'variety of data collection' methods to collect detailed information (Stake, 1995; Yin, 2009, 2012). Yin identifies four types of case study design, each with variations depending on the number of units of analysis and case studies. For example, one case study with multiple units of analysis or multiple case studies with one unit of analysis (Yin, 2009, p.46). The unit of analysis is the ‘major entity' that the inquirer is analysing in the study (Yin, 2009, p.46). For this Curriculum Inquiry, the case study is the Industrial Design curriculum at TEC, in Mexico and the units of analysis are the multiple participants in the inquiry; the groups of students (Industrial Design and Architecture at TEC), the Industrial Design and Architecture professors / teachers, at TEC and the external experts, participating in the Curriculum Scoping and the Focus Groups.

The methodology for this inquiry incorporates a mixture of qualitative and quantitative methods. Informed by Creswell (2014) and Zidane (2015), the inquirer's selection of a 'mixed methods' approach (Creswell, 2014, p.31) for this inquiry is explained below (p.82).

3.2. The paradigms guiding the Curriculum Inquiry

As introduced in Chapter 1 (p.17) and expanded upon in Chapter 2 (p. 34), this inquiry investigates an Industrial Design curriculum through local, national and global SD and ESD discourses. This section extends the discussion on design paradigms (p.36) to the concept of 'research paradigms' (Zidane, 2015, p.5) with the aim of explaining how their combination guides the inquirer's research design.

The Literature Review outlined the change from the 'old unsustainable [...] design paradigm to a sustainable paradigm' (Stebbing & Tischner, 2015, p.10) and from a focus on 'producing goods' to addressing 'new challenges such as sustainability' in relation to 'complex systems' (Iniguez, 2016). In the context of research design, ‘the existence of different research perspectives has led to the emergence of research paradigms’ (Zidane, 2015, p.5). These perspectives guide how a study is conducted (Creswell 2014, p.34). In this regard, Creswell proposes that when planning a research design, the inquirer ‘needs to think through the philosophical worldview assumptions that they bring to the study’ (Creswell, 2014, p.34). Creswell describes a worldview as a ‘general philosophical orientation about the world and the nature of research that a researcher brings to a study’ (Creswell, 2014, p.34). Creswell identifies four worldviews: postpositivism, constructivism, transformative and pragmatism (Creswell, 2014, p.35).

> Pragmatism does not insist upon antecedent phenomena but upon consequent phenomena, not upon the precedents but upon the possibilities of action’
> (Sanders, 1982, p.22).

The inquirer considers that this emphasis on 'the possibilities of action' for situations in the future (Sanders, 1982) is suited to:

- guiding the research design for the curriculum change objective of this practitioner-led action inquiry
- addressing the evolving nature and complexity of the research problem (Zidane 2015, p.57) and
- enabling the Curriculum Inquiry to address 'applications and solutions to problems' (Creswell, 2014, p.36).

Robson proposes that 'much real world research is sparked off by wanting to solve a problem, or a concern for change and improvement in something to do with practice' and is suited to fields in which practitioners want to research an aspect of the situation in which they work (Robson 2002, p.47).

As highlighted in Chapter 2 (p.36), the inquirer's research design is guided by the new paradigm of design; the 'new challenges of sustainability' (Iniguez, 2016) and pragmatism that are aligned to the research objectives and questions:

- the need for Design ESD to address the realities of SD-ESD, in different contexts and as they evolve (Iniguez, 2016, p.35);
- the need for practitioners to improve ESD, in practice, in the real-world context of higher education in Mexico;
- rational principles and ethical values, considered to be best suited to answering the research questions; directed to finding ways of improving ESD in Mexico (Whitehouse, 2014, p.1).

3.3. The research design: cycles of actions using mixed methods

UNESCO proposes a multi-stakeholder consultation process to identify ‘essential knowledge, skills, values, perspectives, and issues important to a more sustainable future of a community or a country’ (UNESCO, 2012, p.44). Then, ‘a gap analysis between the current curriculum and the results of the consultation process can identify necessary additions to the curriculum’ (UNESCO, 2012, p.44). This approach was considered in the design of the methods applied at TEC in Cycle 1.

According to Yin (2009), a research design is a ‘logical plan’ for developing from the initial set of questions to be answered to a set of conclusions about them (Yin, 2009, p.26). The selection of the research design for this case study follows the logic of a sequence of 'action research cycles' (McNiff et al., 2003, p.23). These cycles:

- are 'ways of disciplining the research process' McNiff et al., 2003, (p.23)
- enable new or adjusted questions to be 'addressed as they emerge through the [research] process' (McNiff & Whitehead, 2010, p.11) and that
- allow for flexibility; as the findings from each cycle are evaluated the standpoint of the inquirer 'held at the start of [the] research' can change according to a developing and / or changing 'understanding of the situation'; resulting from the inquiry (McNiff et al., 2003, p.41).

The research design is also informed by the ability of 'mixed methods', incorporating quantitative and qualitative data, (Creswell, 2014, p.43) to:

- explore the variables of the curriculum inquiry, involving multiple stakeholders; 'different actors and disciplines' (Iniguez, 2016)
- allows for the collection of detailed data, necessary to address the 'challenges of sustainability [through] a broad and systematic vision that allows the incorporation of many variables' (Iniguez, 2016)
- enable 'the practice of triangulation to collect rich and varied information and to generate new ideas' (Zidane, 2015, p.57) and to
- offset the 'bias and weaknesses' of a research method when used alone. That is, the collection of data using combinations of qualitative and quantitative methods helps to address the 'weaknesses of each form of data' (Creswell, 2014, p.43)
- enable 'a more complete understanding of a research problem than either approach alone' (Creswell, 2014, p.32)

The research approach recognises that the inquirer is both a stakeholder and a practitioner in the inquiry; that the context of curriculum change at TEC (Tec21 Educational Model) acts as a catalyst for the inquiry and that the inquirer is using her own teaching practice alongside this SD-centred inquiry to contribute to curricula change. This means that the inquirer’s position could result in a biased approach to the research. As mentioned above, this potential bias is addressed by using mixed methods research.

3.3.1. Action research working in cycles

Based on the reconnaissance period of this case study (McNiff et al., 2003), the inquirer recognised that fundamental pedagogical change would be needed to achieve the curriculum change objectives of the research and that the use of action inquiry, involving the multi-stakeholders in the inquiry, had

the potential to affect this level of change. In this case, the stakeholders contribute to the research by participating in interventions in the curriculum, data collection methods and Focus Groups.

In exploring 'research approaches' in relation to 'the interpretive nature of design', Swann refers to Schon's formulation of 'an epistemology of practice based largely on an examination of the way in which practitioners reflect on their actions during and following their work' (Swann, 2002, p.50). As referenced in the Literature Review, pp.53-54, Swann goes onto describe how action research is 'a practical research methodology that usually is described as requiring three conditions to be met (Swann, 2002, p.55).

> First, its subject matter normally is situated in a social practice that needs to be changed; second, it is a participatory activity where the researchers work in equitable collaboration; and third, the project proceeds through a spiral of cycles of planning, acting, observing, and reflecting in a systematic and documented study.
> (Kember & M. Kelly, 1993 cited in Swann, 2002, p.55)

The inquirer considers that the above conditions are connected to the following requirements to be met through this inquiry.

- the reorientation of the Industrial Design curriculum
- the use of a participatory research methods, involving the multiple stakeholders in the inquiry and
- the thesis systematically documenting the cycles of the inquiry

According to McNiff (2002, p.8), different models and interpretations of action research have been developed over time, some of which focus on ‘technical aspects’, while other models are based on the ‘values that inform action

research' and/or 'non-linear' approaches. McNiff (2002) argues that, as there is no fixed action research methodology, the inquirer's research design should be suited to the research problem and develop as the 'meaning' that the inquiry has for the inquirer emerges through the research process (McNiff 2002, p.8)

McNiff proposes a model of learning, where 'practitioners are challenged and helped to find new ways of doing things' (McNiff, 2002, p.27). For McNiff, an 'action plan [involves] action reflection as a cycle, through which the researcher identifies 'an area of practice to be investigated', does the investigation and then adjusts the practice in the 'light of the evaluation' of the findings (McNiff, 2002, p.11). This cycle can then provide a foundation for 'new action research cycles, as new areas of investigation emerge' (McNiff, 2002, p.11). These processes can be expressed as a 'spiral of cycles', through which one activity 'forms the basis of another' and, as one question is addressed, 'the answer to it generates new questions' (McNiff, 2002, p.11).

3.4. The organisation and methods of the Curriculum Inquiry

The cycles of the Curriculum Inquiry correspond to TEC's academic calendar. Table 2., below (p.86) presents the organisation of the inquiry according to this calendar.

The Curriculum Inquiry comprises three cycles:

Cycle 1: The Curriculum Scoping
Cycle 2: Curriculum Interventions and Student Course Surveys and
Cycle 3: Focus Groups

Cycle 1 explores the scope of the inquiry. It develops from collecting and analysing data on the national and international contexts of ESD, in relation to

design, to narrowing this process to the national context of the Industrial Design curriculum at TEC. In this way, Cycle 1 lays a groundwork of perspectives and opinions to inform the development and practice of the Curriculum Interventions in Cycle 2, including the formulation of SD competencies to be implemented in the interventions. After analysing the data collected from the interventions in Cycle 2, Cycle 3 presents the main findings from the Curriculum Inquiry to Focus Groups (the participants / stakeholders in the inquiry). The participants in these groups are invited to discuss their reflections and opinions on the relevance and validity of the outcomes of the research. It is worth noting that the majority of the participants in Cycle 3, also participated in Cycle 2.

The table below (Table 2), provides a map of the inquiry in relation to TEC's calendar, the four years of the research and the University's Tec21 Educational Model. It is important to note that this model was implemented from the start of the academic year 2019-2020 and that Competency-Based-education (CBE) was applied to the curricula for the first time at TEC in August 2019, at the start of the academic year 2019-2020.

During 2019, the inquirer received NOVUS funding from TEC. NOVUS supports educational innovations and educational experimentations. This permitted the development of the online SD learning space named Sostek. As introduced earlier (p.32), this unplanned activity emerged from the First (Trial) Curriculum Intervention.

Table 2. The Cycles of the Curriculum Inquiry

<table>
<tr><th colspan="2">TEC Calendar</th><th colspan="3">Curriculum Inquiry</th></tr>
<tr><td>Fall Sem</td><td>Spring Sem</td><td>Research Year</td><td>Cycle</td><td></td></tr>
<tr><td>August – December 2016</td><td>January - May 2017</td><td>1</td><td rowspan="2">1</td><td rowspan="2">The Curriculum Scoping</td></tr>
<tr><td>Aug 2017 – Dec 2017</td><td>January - May 2018</td><td>2</td></tr>
<tr><td>Aug 2018 – Dec 2018</td><td>January - May 2019</td><td>3</td><td>2</td><td>First Curriculum Intervention (trial) (Industrial Design)

NOVUS application to support the creation of Sostek

Second Iteration of the Curriculum Intervention (Industrial Design)</td></tr>
<tr><td colspan="5">Start of Tec21 educational model</td></tr>
<tr><td rowspan="2">Aug 2019 – Dec 2019</td><td rowspan="2">February - June 2020</td><td rowspan="2">4</td><td>2</td><td>Third Iteration of the Curriculum Intervention (Industrial Design and Architecture)</td></tr>
<tr><td>3</td><td>Focus Groups</td></tr>
</table>

The mixed methods approach to the study was based on the inquirer's belief that a broad and open approach to data collection would be best suited to eliciting a variety of opinions and viewpoints from the participants in the inquiry.

The following tables (Table 3., Table 4), present the methods, locations and participants for Cycle 1 and Cycle 2. In Cycle 2, three Curriculum Interventions were applied at the Puebla campus. The first two interventions were applied to the Industrial Design programme before the implementation of the Tec21 Educational Model and CBE. The third iteration was applied to the Industrial Design programme and for the first time, to the Architecture programme.

Table 3. Cycle 1: research methods, locations and participants / stakeholders

Cycle 1: The Curriculum Scoping				
Academic year	**Semester**	**Method**	**Locations**	**Participants / stakeholders**
2016-17	Summer	Interviews with Experts (general context)	UK: Leeds, London, Birmingham Mexico: Guadalajara; Puebla; Queretaro; Monterrey; Mexico City	Experts: professors, inquirers, professionals from universities, Companies, Institutions and Government
2016-17	Summer	Community of Practice Seminar (general context)	Birmingham City University, UK / Tecnologico de Monterrey, Mexico	External experts, professors and students
2017-18	Fall	Nationwide Questionnaire (general level)	14 Universities in Mexico	Industrial Design Professors
2018-19	Fall and Spring	Curriculum Scoping at TEC (specific level)	TEC campuses: Guadalajara; Monterrey; Toluca; Puebla	TEC professors, directors, graduates and students
2018-19	Fall and Spring	Curriculum Scoping Walking Interviews (specific context)	Puebla	TEC professors

Table 4. Cycle 2: research methods, locations and participants / stakeholders

Cycle 2: Curriculum interventions / Student Surveys, Trial and Second Iterations				
Academic year	Sem	Method	Location	Participants
2018-19	Fall	Competency-based student survey to measure 5 SD Competencies	Tecnologico de Monterrey, Puebla	Industrial Design students from the 3rd to the 9th semester
2018-19	Spring	Competency-based student survey to measure 5 SD Competencies	Tecnologico de Monterrey, Puebla	Industrial Design students from the 3rd to the 9th semester. Industrial Design Professors
Cycle 2: Third Iteration of Curriculum interventions				
2019-20	Spring	Student Course Survey to measure 5 SD competencies	Tecnologico de Monterrey, Puebla	Design and Architecture students from the 3rd to the 9th semester. Industrial Design; Architecture professors

3.4.1. Research Methods: Cycle 1: Curriculum Scoping

Multiple stakeholders (academics, students, professionals and industrialists) in the fields of Design and Architecture, participated in this first cycle. The methods were designed to collect and analyse qualitative and quantitative data, relevant to general SD and ESD themes and to inform the development of specific curriculum themes, methods and approaches in preparation for the Curriculum Interventions in Cycle 2. In this way, the process of scoping developed from exploring the more general contexts of the inquiry to narrowing its focus to the Industrial Design and Architecture curricula at TEC. The inquirer conducted:

- semi-structured Interviews with Experts
- a Nationwide Questionnaire, applied to TEC and 16 other universities in the different zones of Mexico.

The following interviews, conducted by the inquirer at TEC's Puebla and Toluca campuses, narrowed the focus of the inquiry to the University's Industrial Design curricula:

(1) a group of 15 Industrial Design students
(2) a group of 8 Industrial Design and Architecture professors and curriculum developers; members of TEC's Academic Aspect Undergraduate Team (EAAC)
(3) a group of 8 Industrial Design graduates.

In Cycle 1, two unplanned methods were added to the original plan:

(1) In Cycle 1, a Community of Practice seminar was conducted in the UK, comprising a multidisciplinary group of students and academics in Design and Architecture
(2) Walking Interviews. The section below, 3.5.4.3. (p.102) outlines the application of this method in the inquiry

The above data collection methods were designed to lay a groundwork of data to inform the Curriculum Interventions in Cycle 2.

3.4.2. Research Methods: Cycle 2: Curriculum Interventions

The specific objective of this cycle was to investigate the experiences of students and professors, participating in the Curriculum Interventions through Student Course Surveys, applied to the Design and Architecture curricula at TEC's campus, in Puebla. A Trial Curriculum Intervention was undertaken during the 2018 Fall semester, to revise and refine the formulation of SD competencies and the Student Course Survey. As presented in Table 4 above, this was followed, in the 2019 Spring and Fall semesters, by two further iterations of the interventions.

Additional, unplanned interviews with participants in the Curriculum Interventions (students, teachers / professors) were conducted to review and discuss the effectiveness of the interventions, as they were being undertaken.

The main findings from Cycle 2 informed the formulation of the questions for the Focus Groups in Cycle 3, the concluding cycle of the inquiry.

3.4.3. Research Methods: Cycle 3: Focus Groups

This cycle comprised three Focus Groups. The table below (Table 6) provides details of the three groups of participants who were invited to reflect on and evaluate the relevance and validity of the main findings from the Curriculum Interventions. They were also invited to offer their opinion and viewpoints on Sostek, the online learning space. As described in Chapter 1 (p.32), this unplanned activity responded to a finding from the first intervention. Chapter 5 is dedicated to this and other unplanned outcomes from the inquiry.

Table 6. Focus Groups participants (Spring semester, 2020)

Cycle 3: Focus Groups		
#	Location	Participants / Moderator
First (Trial) Focus Group: Students	Gesell Chamber, Puebla campus	Industrial Design students who participated in the first (Trial) Curriculum Intervention (Cycle 2) provided their reflections and viewpoints on the results of the research and the online learning space.
Second Focus Group: Professors	Gesell Chamber, Puebla campus	Design and Architecture professors from TEC (Puebla). Three of the participants participated in the Curriculum Interventions.
Third Focus Group: External guests	Gesell Chamber, Puebla campus	External guests: an industrial designer who works as a strategy, innovation and sustainability consultant; a biologist with a Master's degree in climate change and who is a part-time professor at TEC; a visiting professor from the Netherlands; a Green Carson employee who teaches a subject in Engineering at TEC; a government employee who works as director of technological innovation and the manager of social responsibility at a renowned developer of real estate projects in Puebla.
First, Second and Third Focus Groups	Gesell Chamber, Puebla campus	The moderator was a full-time professor of the Architecture department.

The organisation of the Curriculum Inquiry involved the inquirer in learning from cycles of 'concrete experience' (Hill, 2014, p.6), encompassing the scoping of the inquiry to understand the formulation and introduction of the five SD competencies in the Curriculum Interventions, followed by reflection and analysis through conducting the Student Course Surveys, the planned and unplanned interviews with the multiple stakeholders in the inquiry and the Focus Groups.

The next sections, 3.5. to 3.7., describe in more detail the research methods applied in each cycle of the Curriculum Inquiry.

3.5. The Curriculum Scoping methods: Cycle 1

The data collection methods used in the Curriculum Scoping were designed to develop a more comprehensive understanding of the research problem and how the Curriculum Interventions, in Cycle 2, could address the research objectives of integrating sustainable into the Industrial Design curriculum at TEC and into TEC´s initiatives. The researcher used a combination of manual and electronic process to analyse the data collected from the methods applied in this cycle (Cycle 1). For the manual processes, with the agreement of the participants, the inquirer made audio recordings of the interviews, and produced transcripts of the audio recordings in Spanish (for the Spanish speaking participants and then translated the transcripts from Spanish into English (for English speaking participants and the writing of the thesis and related publications). The electronic processes were used to analyse and organise the numerical and text data, as well as to apply formats to visualise the data. These techniques were applied to inform the design of the methods of the inquiry in advance of Cycle 2 and then Cycle 3, and to inform adjustments and additional activities to the inquiry as it developed. Electronic processes were also used to inform the ordering of information into tables, as well as to create graphs to present the information in a summarised way and to carry out searches and analyses within the data.

3.5.1. The Interviews with Experts

The Interviews with Experts involved the participation of twenty-three academics, professionals and industrial leaders, with expertise in Architecture and Design, in Mexico and internationally. A total of twenty-three interviews

were conducted. Sixteen of these were conducted in Mexico and seven in the UK.

Of the sixteen experts who were interviewed in Mexico, nine are Industrial Design and Architecture professors at TEC, seven have specialist SD and/or EDS knowledge, five are leaders of TEC's Design and Architecture undergraduate degree programmes (Querétaro, Monterrey, Guadalajara and Puebla campuses), one is the co-founder of a social design association, and one is a full professor at the University of the Americas Puebla. The above experts included a graduate from TEC who is a CEO of an energy efficiency and solar energy company in Mexico, the first Design Programme Director at TEC, an industrial designer from Brazil, who was a UNESCO counsellor, a Regidor of urban development of Puebla and an industrial designer form Japan and online professor at TEC, Puebla.

The seven experts who were interviewed in the UK comprised the following participants: a research fellow (University of Leeds), who specialises in social innovation; the Director of a Museum in London, a teaching fellow (University of Leeds) who specialises in lens-based media: a senior tutor and Postgraduate Course Director at Birmingham City University (BCU); a tutor on the Product Design Undergraduate programme at BCU; the MA Product Design Course Director at BCU and a tutor in the School of Engineering and the Built Environment at BCU.

As identified in Chapter 3 (p.91), the interviews focused on eliciting the participants' opinions and viewpoints on ways of improving sustainable development (SD) and education for sustainable development (ESD). The interviewees were asked to consider the following six questions:

1. What are the key drivers and facilitators for sustainable development (and why is such development of importance)?

2. What, if any, are the factors that are blocking or retarding sustainable development?

3. What might be done to diminish or eradicate such blockages?

4. In what ways might the education sector (and more specifically, the higher education sector) contribute to the promotion/achievement of sustainable development?

5. What are the current ‘big issues’, or open questions in relation to sustainable development?

6. If you have been involved in sustainability-oriented innovations, how were these designed, how did they perform, what made them successful (or not), and what was learned from the process?

The experts were also invited to propose ways of integrating SD into a Product Design curriculum.

The findings from the Interviews with Experts contributed to informing the design of the questions for the Nationwide Questionnaire (Cycle 1) and the design of the Curriculum Interventions in Cycle 2, including the formulation of SD-competencies, to be applied in the interventions. Chapter 4 (p.112) presents the main findings from the Interviews with Experts in combination with those from the Literature Review, drawn from local and international perspectives. Their combination provided a useful way of building a more comprehensive understanding of the research problem from a range of perspectives. The Interviews with Experts questions can be reviewed in Appendix B (p.215) and a summary of the results of the interviews in Appendix G1.1.1. (p.227)

3.5.2. The Community of Practice seminar

In August 2017, during the inquirer's visit to Birmingham City University (BCU), in the United Kingdom, a 'Community of Practice' seminar was conducted at the University. The seminar comprised teachers at BCU and visiting students from Mexico. The seminar was arranged as an impromptu addition to the planned methods of the Scoping of the Inquiry. The participants, who were from the disciplines of Design, Architecture, Visual Communications and Law, were invited to discuss ways of improving education for sustainable development. The seminar provided an early opportunity for the inquirer to present the research topic outside of Mexico.

A record of the seminar discussion is available in Appendix G.1.1.2. (p.262) and Chapter 4 (p.112) provides a summary of the contributions of the participants.

3.5.3. The Nationwide Questionnaire

A total of thirty-one participants answered the questionnaire from November to December 2017. The questionnaire format can be reviewed in the Appendix C (p.216) and the results in Appendix G1.1.3 (p.265).

As mentioned above, the findings from the Interviews with Experts informed the development of questions for the Nationwide Questionnaire, which focused on collecting and analysing qualitative and quantitative data on existing pedagogical approaches to ESD in undergraduate Industrial Design programmes, in Mexico. The participants were asked to consider the extent to which SD is included in their curricula and how their universities measure the effectiveness of SD learning and teaching. There are twenty-one universities (public and private) in Mexico that offer a four-year undergraduate programme in Industrial Design. The questionnaire was sent to all of them, fourteen

academics from eight public and six private universities in Mexico participated in the questionnaire. Therefore, the researcher was satisfied that the survey covered a representative sample for the population of the survey. This enabled the findings from to be generalised within the national context of the inquiry. The majority of the 23 questions were formulated to elicit qualitative data. Four questions (5, 6, 7 and 22,) requested quantifiable responses.

The Nationwide Questionnaire built upon the insights drawn from Interviews with Experts and the Community of Practice seminar to establish a groundwork of data from which the narrow the focus of the Curriculum Scoping to its specific setting at TEC. The next section outlines the Curriculum Scoping methods applied at TEC. Chapter 4, (p.125) presents the main findings from the Nationwide Questionnaire and how they contributed to developing curriculum themes and markers for the reorientation of the Industrial Design curriculum. The complete results of the Nationwide Questionnaire can be reviewed in Appendix G1.1.3, p.265.

3.5.4. The Curriculum Scoping methods applied at TEC

As identified in Chapter 2 (p.58), the university's new curricula commenced from August 2019, allowing the inquirer to discuss the developing findings from the Curriculum Inquiry with the Academic Aspect Undergraduate Team (EAAC). As introduced earlier (pp.21,90), the EAAC team of professors from four of TEC's campuses leads and guides the national development of the university's curricula. As the inquirer is a member of this team and a professor in the Department of Industrial Design and Architecture, the interviews at TEC were undertaken at a discipline level, in parallel with the University's nationwide programme of curricula change, aligned to the Tec21 Educational Model.

The methods applied at TEC comprised semi-structured (group and individual) interviews and ‘walking interviews. As outlined above (Table 6, p.93), the inquirer interviewed Industrial Design students, professors, directors and graduates. The inclusion of 'walking interviews' was guided by findings from the Literature Review (p.33) and the Interviews with Experts, which identified the need for a systemic approach to the reorientation of the Industrial Design curriculum, by which learning embraces different environments (Expert A, 2017; Expert E, 2017). The design of the ‘walking interviews' method for this inquiry is presented below (p.101).

Informed by the previous scoping methods, the interview questions asked the participants to reflect upon the main findings from the Curriculum Scoping so far. This contributed to narrowing the focus of the inquiry to the Industrial Design curriculum at TEC, as a basis for informing the Curriculum Interventions in Cycle 2. The formulation of the questions was guided by the important finding from the Literature Review (Chapter 2, p.33) and the Interviews with Experts (p.88), that the complexity of the design project (Iniguez, 2016, p.24) and the challenges of sustainable development (SD) demand a systemic approach to the reorientation of the Industrial Design curriculum (Iniguez, 2016, p.24). The questions were formulated to explore the participants' viewpoints on the practical application of concepts of SD and to collect data on their involvement in current SD-related projects, ways of measuring SD learning and multidisciplinary approaches to SD at TEC.

3.5.4.1. The locations of the Curriculum Scoping at TEC

The interviews at TEC were conducted as group meetings and applied at four different campuses. Ten TEC campuses teach undergraduate Industrial Design programmes. In the table below (Table 7), an asterisk identifies the four campuses where the Curriculum Scoping methods were applied. The

interviews at the Puebla and Toluca campuses were conducted face-to-face and the interviews at the other campuses took place online.

Table 7. Campuses teaching the undergraduate Industrial Design programme

TEC zones	Campuses
North Zone	Monterrey* (headquarters), Sonora Norte and Laguna
Mexico City	Mexico City (headquarters) and Estado de Mexico
South	Puebla* (headquarters) and Toluca*
West	Guadalajara* (headquarters)
Central	Queretaro (headquarters) and Leon

The university has 36 campuses, located in the following Zones: North: Mexico City; South; West and Central. The ten campuses, which offer the Industrial Design programmes are: Monterrey, Sonora Norte and Laguna in the North Zone; Mexico City and Estado de Mexico in the Mexico City Zone, Puebla and Toluca in the South Zone, Guadalajara in the Western Zone and Queretaro and Leon in the Central Zone. In addition, a further three campuses offer the first year of the undergraduate Industrial Design curriculum: Cuernavaca and Hidalgo in the South Zone and San Luis in the North Zone. The Monterrey campus is the headquarters of the North Zone and where TEC was founded in 1943. The Monterrey campus is also where the university's Industrial Design programme was introduced in 2000. The Guadalajara campus is the headquarters of the Western Zone and is also the headquarters of the National School of Architecture, Arts and Design of TEC.

3.5.4.2. The Interviews at TEC

The interviews with Industrial Design professors, students and graduates at TEC were undertaken at the Puebla, Toluca, Guadalajara and Monterrey campuses, enabling the collection of data to reflect the national context of the

university, across Mexico's different zones. These interviews comprised two iterations: a pilot and a second iteration.

Ten professors, sixteen students and three graduates participated in the pilot interviews undertaken at the Puebla campus (headquarters of the South Zone) and at the Toluca campus (South Zone). The second iteration of the interviews involved the participation of seven Design professors, twenty current students and four graduates at the Guadalajara and the Monterrey campuses. The Monterrey campus was considered important as the location for this second iteration, as it is the 'matrix' of the university, as well as the headquarters of the North Zone. The Guadalajara campus was also selected as it is the headquarters of the National School of Architecture, Arts and Design of TEC, as well as being the headquarters of the Western Zone.

The pilot interviews at the Puebla campus informed two adjustments to the interviews for the subsequent interviews at TEC. The following question was added at the beginning of the interview:

> What, for you, constitutes SD?

This open question responded to the tendency of the participants in the pilot interviews to perceive the concept of SD, in the more restricted contexts of 'eco-design' or 'green design'. As a result of opening the interviews to broader questions of SD, the participants contributed their viewpoints and opinions on social activities and related projects. The second adjustment was the addition of the following question, which intended to elicit more specific information on any SD-related projects and/or activities, which the interviewees had led at TEC:

> Can you give an outline of the projects or activities related to sustainable development that you have led in your classes?

3.5.4.3. The 'walking interviews' at TEC

According to Kinney, a 'toolkit' developed by Emmel and Clark (2009, pp.1-24) offers inquirers who are conducting interviews, 'insights into what [they] should consider' (Kinney, 2017, p.2). For Kinney (2017), an important advantage of the 'walking interviews' method is that participants can be 'in control of the interview' and 'regarded as experts in their geographical area'. Similarly, Strang proposes that this participatory and observational method enables inquirers to explore 'people's historical and contemporary relationships with local environments [and to] collect social, historical and ecological data in situ' (Strang, 2010, p.1). In this context, the inquirer argues that the campus, or any University environment, should reflect the content, values and beliefs of a curriculum, as in this way, the students can experience the curriculum all around them. The inquirer believes that this can result in a mutually reinforcing affect, whereby the campus resonates with the taught curriculum. That is, the students can see if what is talked about in the curriculum is present in their learning environment. Therefore, the inquirer decided to apply the 'walking interviews' method with the specific objective of adopting this systemic approach to the Curriculum Inquiry at TEC. The method involved collecting data on the observations of the inquirer, professors and students, on walks around the campuses.

This method was first applied at the Puebla and Toluca campuses (South Zone) to evaluate and refine its design before applying it to the Guadalajara (West Zone) and Monterrey (North Zone) campuses.

The table below (Table 8) presents the recording method, designed by the inquirer, for the 'walking interviews' at TEC. The participant is invited to select and photographically record a subject.

Table 8. The 'walking interviews'

Location: Brief description of the location Date of the interview: Photograph by: Interviewer: Interviewee:	
Image	Annotation
	The interviewee's descriptive commentary on the image
Interpretation	
The interviewee's commentary on what the image communicates	

Figure 3. Examples of photographs taken on the Puebla campus of Tec de Monterrey (2018)

Informed by the findings from the use of this method at the Puebla campus, adjustments were made in preparation for applications of the method at the Toluca, Guadalajara and Monterrey campuses. The adjustments were:

- the participation of students and professors at each campus was included
- the inclusion of annotations to describe the subject of the photograph and record interpretations of possible meanings
- the use of a map of the campus to randomly identify locations and viewpoints and a predetermined route was introduced to counter prejudged selections of topics by the interviewer of interviewee

The 'walking interviews' method contributed to exploring ESD in the context of a systemic approach to the curriculum. That is, the data collected at TEC included observations of the curriculum in action, in formal and everyday learning and teaching situations and environments, allowing the inquiry to experimentally apply a method through which to explore how the campus environment influences learning and teaching experiences.

The inquirer found that this method complemented the previous methods applied in the Curriculum Scoping in the following ways:

- The participants were able to contribute their own interests, perspectives and values to the interviews.
- The information collected focused on the campus environment, counterbalancing the tendency of the previous methods to concentrate on the more formal aspects of the curriculum.

3.6. The Curriculum Interventions methods: Cycle 2

The findings from the Curriculum Scoping (Cycle 1) informed the design of the Curriculum Interventions in Cycle 2, the specific objectives of which were to integrate sustainable development content and the measurement of SD-oriented competencies into the Project courses of the undergraduate Industrial Design and Architecture curricula at TEC's Puebla campus. This enabled the use of competency-based education to be applied to the Industrial Design and Architecture curricula before the formal implementation of this system across the University from the Fall semester 2017. Student Course Surveys were used to collect and analyse data on the students' evaluations of their development of the competencies. The results of the Student Course Surveys are presented and analysed in Chapter 4 (p.141).

As presented in the tables above (CI.2 and CI.3, pp.83,86), Cycle 2 comprised three interventions in the curriculum. The first two were applied to the Project courses of the Industrial Design programme. The third intervention was then applied to the same courses of both the Industrial Design and Architecture programmes. The SD competencies, informed by the Curriculum Scoping, provided a basis for the professors, teaching the Project courses, to design specific assessment criteria for their courses. The next chapter (Chapter 4, p.129) describes the Curriculum Interventions in more detail and presents the main findings from the Student Course Surveys. These findings formed the basis for formulating the questions for the Focus Groups in Cycle 3, the concluding cycle of the inquiry.

The inquirer applied a combination of manual and electronic processes to analyse the data collected through the interventions. With the agreement of the participants, the inquirer made audio recordings of the surveys with students, produced written transcripts and translated the transcripts from Spanish into English. The electronic processes were applied to organise the numerical and text data as well as to apply formats to visualise the data in

ways that enabled the inquirer to present the results in a clear and condensed way. Electronic processes were also used to order the information into tables and to create graphs to visualise the information in a summarised way.

3.7. The Focus Groups method: Cycle 3

According to Lather (1986), avoiding tendencies for inquirers to hold certain attitudes and beliefs when undertaking research 'requires techniques that will give confidence in the trustworthiness of data' (Lather, 1986, p.66). In this regard, the inquirer considers that focus groups provide a reliable method of 'triangulation', as they combine 'interviewing and participant observation' (Lather, 1986, p.72).

The following description of qualitative interview methods, provided by Creswell, guided the inquirer's design of the Focus Groups.

> In qualitative interviews, the researcher conducts face-to-face interviews with participants, telephone interviews, or engages in focus group interviews with six to eight interviewees in each group. These interviews involve unstructured and generally open-ended questions that are few in number and intended to elicit views and opinions from the participants.
> (Creswell, 2014, p.239)

According to Krueger et al. (2001), 'the basic sampling strategy is to conduct three or four focus groups for each audience category that is of interest' (Krueger et al., 2001, pp.6-7). The original plan was to conduct one Focus Group. However, based on the review of the literature on focus groups (Creswell, 2013; Krueger et al., 2001) and the experience of collecting data

through group meetings earlier in the inquiry, the inquirer decided to conduct three Focus Groups as this would enable the collection of more focused data from the three groups of participants; students, professors and external guests.

Table 6 (p.93) presented the participants in the three Focus Groups. Two of the professors had participated, as interviewees, in the Interviews with Experts in Cycle 1 and three of the professors had participated in the Curriculum Interventions (Cycle 2). Using pre-determined questions, the participants were invited by the moderator to reflect on and discuss the main findings from the Curriculum Interventions. The questions for the students and professors were formulated to open discussion on the differences that the interventions had made to the students' SD learning and to the professors' approaches to learning and teaching. The questions for the external guests were prepared to open discussion on the ways in which they were promoting SD in their companies. The interviewees in each of the Focus Groups were also asked to comment on the development of the online learning space. As highlighted earlier (p.91), this initiative was developed in parallel with the research, initially as a learning tool to support the participants in the interventions. As the inquiry developed, the vision for online the learning space broadened to become an open access platform for any user. The questions for the Focus Groups can be reviewed in Chapter 4, (pp.151-153-156) and in Appendix G1.3 (p.396).

It is important to note that the researcher informed the participants in the Focus Groups that the sessions would take place in the Gesell chamber, on campus, that the sessions would be guided by a professor unrelated to the research, and that the role of the researcher would be as an observer, located on the other side of the glass wall of Gesell's chamber. This information was included in the invitations, sent by the researcher to the participants.

3.7.1. The specific methods of the Focus Groups

The inquirer selected a moderator, who was not involved in the inquiry, to lead the Focus Groups. According to Krueger et al., (2001):

> the moderator should have enough knowledge about the topic to understand what the participants are saying. He or she does not need to be an expert on the topic but should understand common terms that will be used in the discussion
> (Krueger et al., 2001, p.11)

As a member of TEC's EAAC team, a professor in Architecture (undergraduate degree in Urbanism) and an architect with an interest in sustainability, the moderator's knowledge was well suited to the topic of the inquiry. Prior to the Focus Groups, the inquirer met with the moderator to provide a plan for the presentation of the main findings from the inquiry and to discuss the set of predetermined open questions, prepared by the inquirer, for the Focus Groups. For each group, the moderator presented the main findings from the interventions before asking the questions to open discussion. Each question had a leading question, followed by related sub-questions.

The inquirer applied a combination of manual and electronic processes to analyse the data collected in Cycle 3. With the agreement of the participants, the inquirer made audio recordings of the Focus Group meetings and transcribed and translated the recordings from Spanish to English.

3.7.2. Sampling, number of groups and location of the Focus Groups

The Focus Groups were conducted in a Gesell chamber (Puebla campus), enabling the inquirer to observe from an adjoining space and out of the view of the moderator and interviewees, the conversations between the moderator and the participants (p.158).

Krueger et al. (2001), recommend that the 'researcher conducts [focus] groups in the primary language of the participants and avoids interpreters (Krueger et al., 2001, p.22). In this regard, the Focus Groups were conducted in Spanish, the primary language of most of the participants. One of the interviewees was a visiting professor from the Netherlands, with a good level of Spanish language, as a second language. Following each group meeting, the inquirer transcribed and translated the data collected from Spanish to English for the purpose of this thesis and related publications. The audio recording equipment of the Gesell chamber was used to transcribe the data.

Chapter 4 (sections 4.5.1. to 4.5.4) provides information and analyses of the data collected from the Focus Groups.

3.8. Ethical considerations

The inquirer considered the Birmingham City University Ethical Principles and Practice Policy Statement in the process of designing this inquiry. These were assured throughout the methods applied at TEC by ensuring that the participants' names were not used in the analysis by being substituted with codes. This allowed the inquirer to identify each participant. All students were informed that the Curriculum Interventions were part of an inquiry, focused on curriculum change and in the context of sustainable development and that their cooperation would not affect their grades or offer any tangible benefits.

As described above (p.106), the conduct of the Focus Groups in Cycle 3 was guided by the literature on qualitative research methods in relation to focus groups (Creswell, 2013; Krueger et al., 2001; (Lather, 1986) to avoid the potential for any bias of the inquirer to influence responses of the participants in the Focus Groups.

As mentioned earlier, since 2004, the inquirer's role at Tecnologico de Monterrey has been Professor of Architecture. Therefore, it is recognised that the study is being conducted predominantly by a subjective inquirer, who is an active participant in what is being researched. To offset this situation, the method of triangulation, as described in the Literature Review, was used to reduce potential bias (Chapter 3, p.82). This method involves the consideration of different sources of evidence, viewpoints and research, and analysis methods (Miles and Huberman, 1994, p.266). As part of the process of triangulation, data was collected through multiple sources, including interviews, observations and document analysis (Creswell, 2014, p.259).

There were no other foreseeable ethical considerations arising from the practice or methods incorporated in this study. Robson (2002) proposes that real world research 'can lead to the researcher finding out about practices or conduct which present ethical dilemmas' (Robson, 2002, p.47). The inquirer informed the supervisors of ethical questions as they emerged during the undertaking of the study, and these were evaluated and acted upon according to the University's terms and conditions.

3.9. The design of the Curriculum Inquiry: conclusions

The design of this practitioner-led action inquiry intended to develop an understanding of the scope of the research problem, as a basis to reorientate the Industrial Design curriculum at TEC; thereby contributing to the sustainable development of Mexico. This chapter has outlined the concepts and practices

guiding the research design, including the basis upon which the inquirer selected and applied research principles and values linked to the 'new paradigm' of design and aligned to the imperative of addressing sustainable development (Iniguez, 2016). Informed by the selected literature on research design, the inquirer developed a mixed methods approach, consisting of qualitative and quantitative research methods. This approach intended to support collaboration and the participation of the multiple stakeholders in the inquiry; in systematically exploring ways of reorientating the Industrial Design curriculum through cycles of action, reflection and analysis.

Chapter 4. The Curriculum Inquiry

> The momentum for ESD has never been stronger. Global issues – such as climate change – urgently require a shift in our lifestyles and a transformation of the way we think and act. To achieve this change, we need new skills, values and attitudes that lead to more sustainable societies. Education systems must respond to this pressing need by defining relevant learning objectives and learning contents, introducing pedagogies that empower learners, and urging their institutions to include sustainability principles in their management structures. (UNESCO, 2017, p.1)

4.1. Introduction to the Curriculum Inquiry

This chapter presents and discusses the main findings from:

- the data sources of the Curriculum Scoping in Cycle 1,
- the Curriculum Interventions in Cycle 2, which integrated SD competencies into the Industrial Design Project courses and
- Cycle 3: the Focus Groups, which invited students, professors (participants in Cycle 2) and external guests to reflect on the findings from Cycle 2.

The order of this chapter follows the chronological order of the methods of the inquiry, as presented in the tables in Chapter 3, (pp.86-87-89) and the overall process of the inquiry, as presented in the table below (Table 9). Each of the following three main sections of this chapter provide a summary of the main findings from the three cycles of the Curriculum inquiry.

Table 9. The Cycles of the Curriculum Inquiry

<table>
<tr><th colspan="2">TEC Calendar</th><th rowspan="2">The Three Cycles of the Inquiry</th></tr>
<tr><td>Fall
Semester</td><td>Spring
Semester</td></tr>
<tr><td>Aug – Dec 2016</td><td>Jan- May 2017</td><td rowspan="2">Cycle 1
The Curriculum Scoping</td></tr>
<tr><td>Aug – Dec 2017</td><td>Jan - May 2018</td></tr>
<tr><td>Aug – Dec 2018</td><td>Jan - May 2019</td><td>Cycle 2
Curriculum Interventions / Student Course Surveys
First (Trial) and
Second Iteration (Industrial Design)</td></tr>
<tr><td colspan="3">Start of Educational Model Tec21</td></tr>
<tr><td rowspan="2">Aug – Dec 2019</td><td rowspan="2">Feb - June 2020</td><td>Cycle 2
Third Iteration of the Curriculum Intervention (Industrial Design and Architecture)</td></tr>
<tr><td>Cycle 3
Focus Groups</td></tr>
</table>

4.2. The Curriculum Scoping: Cycle 1

This section identifies the main findings from the data sources of the Curriculum Scoping (Cycle 1) and how they informed the First (Trial) iteration of the Curriculum Interventions in Cycle 2. As described in the previous chapter (p.77), the selected methods were applied to collect a range of perspectives and opinions from the multiple stakeholders in the inquiry. As outlined in Chapter 3 (p.90), the Curriculum Scoping developed from exploring the broader contexts of the inquiry to narrowing the focus of the inquiry to the planned reorientation of the undergraduate Industrial Design curriculum at TEC.

The data sources for the broader contexts of the scoping comprised Interviews with Experts, a Community of Practice seminar, a Nationwide Questionnaire (Design and Architecture academics in fourteen universities in Mexico). The data sources, which focused on the Industrial Design curriculum at TEC, were interviews with professors and students at four different of the University's campuses. Interviews with students and professors in Architecture were also conducted, as this discipline is in the same department as Industrial Design. The interview methods at TEC included the use 'walking interviews', involving a tour of the university campus, to collect data on sustainable development, as experienced by the participants in their university learning environment.

4.2.1. The main findings from the Interviews with Experts

The table below (Table 10), presents the main findings from the Interviews with Experts. The findings are presented as curriculum themes and markers. The themes represent recurring subjects, ideas and arguments, drawn from the interviews and the review of the literature, on related topics. The curriculum markers identify related practical learning and teaching methods and approaches, also informed by the interviews, in combination with the Literature Review. The markers are designed to translate the themes into the practical realities, with the objective of effectively integrating SD into the Industrial Design reoriented curriculum.

This approach to the tables is used for all the tables related to the Curriculum Scoping methods and the Curriculum Interventions. (4.2.1. to 4.6.).

The findings, as identified below, informed the Curriculum Interventions in Cycle 2, introduced in the Fall semester of 2018-19 to the participating students and professors in Industrial Design.

Table 10. Findings from the Interviews with Experts in combination with findings from the Literature Review

	Curriculum themes	Curriculum markers
a	A systemic curriculum	The alignment of all stakeholders in SD: supporting Design ESD curricula change and universities as common arena for collaboration (Expert A, 2017).
		Universities can contribute to improving SD by generating curricula and integrating the subject in all educational programmes and by engaging continuously in SD, as the subject evolves (Iniguez, 2017, p.37).
		The design of any SD curriculum should formalise the integration of sustainability, as a transversal subject (p.61).
b	Knowledge of sustainable development in society: Design curriculum change in Mexico	Design curricula change in Mexico requires the integration of the social dimension of ESD to enable citizen and community participation (Strang, 2010, p.1).
		It is important for ESD to be active outside the classroom to address local realities.
		More interdisciplinary research and development is needed that can have a social impact in Mexico (Expert M, 2017).
c	A practical curriculum	ESD research and development, for social impact, must be increased (Krstikj, 2021; Iniguez, 2016; Stebbing, 2015, p.1)
		The role of higher education in Mexico is fundamental to 'translate change into reality' (Expert D, 2017).
		Practical sustainability: linking the subjects throughout the Bachelor's, so that they are not isolated and can develop interdisciplinary projects (Expert M, 2017).

It is worth noting that, with the aim of guiding the reader, where the text in the following subsections (4.2.1. to 4.6.) is in italics, the intention is to identify the curriculum markers. The first use of this signalling is on page 109.

4.2.1.a. A systemic curriculum

This section outlines three elements of a systemic approach to the curriculum.

- The alignment of all stakeholders in SD, with universities acting as a 'common arena' (Expert A, 2017).
- A systems-thinking approach, addressing SD and ESD as mutually supportive and interdependent (Expert H, 2017).
- The integration of SD into the curriculum, formalised as a transversal subject (Expert A, 2017).

The Interviews with Experts identified that the alignment of all stakeholders is required to improve the sustainable development of Mexico. For example, Expert E argued that the integration of government policy on sustainability and education-industry projects with companies and in society is essential to 'generate systemic ideas' (Expert E, 2017). In this context of alignment and cooperation, Expert A proposed that universities should act as a 'common arena' for the subject of sustainability to achieve a common agreement between the different parties (Expert A, 2017). This thinking resonates with the finding from the Literature Review (p.39) that 'higher education is in the unique position of being the sector where the various demands [of other areas] are integrated' (Benneworth & Arbo, 2006 cited in Jongbloed et al., 2008, p.305). Expert A also stressed that 'if any of the stakeholders are not aligned, sustainable development cannot be achieved' (Expert A, 2017).

In a comparable way but giving particular emphasis to a systemic approach to the curriculum, Expert H proposed that sustainable development concerns

‘tangible environmental, social and economic factors and how these pieces fit together within a systems-thinking approach’. Therefore, the curriculum should address the 'complexity of systems' (Expert H, 2017). This viewpoint reflects the model of SD and ESD as mutually supportive and interdependent. Informed by the Literature Review (p.47), this model is based on the assertion that:

> [n]ot only does education contribute to sustainability and the transformation of society; the reverse is also true. Sustainability improves education and has the potential to transform education. (UNESCO, 2012, p.36)

And that:

> [t]he more universities work on social development, the more sustainable development can be achieved’ (Haaz, 2017).

In the context of a systemic curriculum, Expert N proposed that universities can contribute to improving SD in Mexico by 'generating curricula and integrating sustainability in all educational programmes' (Expert N, 2017), and echoing the finding from the Literature Review (p.47), that sustainability must ‘permeate the entire curriculum' (Stebbing & Tischner,2015), Expert A argued that the design of any SD-centred curricula 'should formalise sustainability as a transversal subject, not as an aggregate [of subjects], nor as an extra subject’ (Expert A, 2017).

4.2.1.b. Knowledge of sustainable development in society

The experts identified the existing deficiency of knowledge of SD in society as a barrier to improving the sustainable development of Mexico. The experts proposed increasing knowledge of SD in society by:

- enabling citizens to participate in ESD (Expert Q, 2017);
- increasing research and development efforts that can have a social impact (Expert L, 2017; Export M, 2017);
- improving, at government level, the continuity of education planning and the alignment of all stakeholders in SD (Expert C, 2017).

Participatory approaches to ESD in society:
TEC's programmes of study are aligned to the university's curriculum framework across the different zones of the university's campuses. Within this framework, Industrial Design projects relate to local and regional contexts. However, for Expert R, although education is a driver for SD in Mexico, in general, there is a need for more education in society (Expert R, 2017). Similarly, for Expert O, a factor restricting the ability of citizens to participate in improving SD is that the subject in Mexico 'is still not well understood',

> People think that it is only about protecting the environment. People rarely include the social aspect.
> (Expert O, 2017)

The experts identified the need to integrate the social dimension of ESD into the curriculum (Expert G, 2017) and argued that [universities must] 'increase their efforts to create programmes with the purpose of enabling citizens to participate in ESD (Expert Q, 2017) and in the specific context of Mexico, Expert G proposed that:

> the great cultural wealth of Mexico's ethnic groups offers the Industrial design profession opportunities to attend to social and sustainable development [and that] each geographical location in [Mexico] can be supported by design students from different universities.
> (Expert G, 2017)

Overall, the experts identified that universities should create sustainable models that relate to local realities and encourage citizen and community participation.

- Expert P, proposed that higher education institutions ‘can do much [by including] sustainable development in the curricula, [promoting] knowledge and citizen participation Expert P, 2017);
- Expert C promoted ESD acting in communities as this enables 'we, as citizens, to know what our responsibilities are' (Expert C, 2017) and
- Expert F argued that the 'traditional classroom model of education' needs to be replaced by projects 'outside the classroom' as this enables the development, 'not only of students' knowledge, but also the knowledge of citizens, as they see the students working in the communities' (Expert F, 2017).

These findings reinforce the UNESCO's argument, as cited in the Literature Review (p.40), that 'importing curricula from other countries or regions is unsuited to ESD objectives, as this approach cannot address local goals and social, and economic contexts' (UNESCO, 2017, p.42).

Research and development projects for social impact:

Expert M proposed increasing 'interdisciplinary research and development that can have a social impact' *(Ex*pert M, 2017). Similarly, Expert L argued that universities:

> must increase research and development efforts, generating research projects, from different disciplines, that can have a social impact. There should be agendas to increase research and development to address social inequality.
> (Expert L, 2017)

According to Expert B, ‘poverty in Mexico surpasses 50% of society' and globalisation, focused on turning Mexico into a manufacturing country, prevents the development of sustainable proposals. The experts also identified the lack continuity in educational planning, the dominance of business interests and In contrast to the model of alignment of all stakeholders, which the experts identified as essential to achieving this goal, for Expert C, although higher education can be a significant driver for SD, ‘without the will of government, it is difficult to reach a development, [in Mexico], where we have isolated actions; there is no plan to work as a team’ (Expert C, 2017).

The above findings, in combination with the Literature Review, informed the curriculum theme of SD knowledge in society.

Aligned with the professional paradigm of TEC, the university encourages student projects to connect to local and regional contexts. The inquirer proposes that the findings from the Interviews with Experts provide evidence that the university's professional paradigm should encompass the social dimension of SD.

4.2.1.c. A practical curriculum

According to Expert V (2017), the term sustainable development is 'contradictory' and the concept of SD is 'contested' (Expert V). Therefore, an important understanding drawn from the Interviews with Experts is that the integration of SD into the Design curriculum requires an exploration of the nature of the subject, as concepts and practices evolve. According to this theme, for Expert D, the role of higher education in Mexico is fundamental to 'translate change into reality' (Expert D, 2017). This expert proposed that while 'empirical knowledge has made many rural organisations succeed, without specialisation, toward organised ways of making [sustainability] real, it is very difficult to make a change' (Expert D, 2017).

With a similar emphasis on the practice of ESD, Expert M highlighted that an important question for SD concerns:

> [h]ow to adapt the curriculum to practical sustainability [and] to link the subjects throughout the Bachelor's, so that they are not isolated and can develop interdisciplinary projects.
> (Expert M, 2017)

Expert E identified that 'learning should not only be theoretical, but practical enough to generate commitment in students, so that later in their working lives, they consider the social approach in all their projects (Expert E, 2017). By connecting practice to personal commitment, this viewpoint, converges with the finding from the Literature Review (p.49) that the curriculum should encompass 'all aspects of the learning/teaching situation' (Leask, 2008, p.12).

The contested and evolving nature of SD influenced the development of ways of integrating SD into the curriculum. That is, the inquirer recognised the need to create a range of learning and teaching methods, enabling the students to explore projects in a range of ways, for example through flexible online resources, multidisciplinary projects, international student competitions, and external projects with companies and in local/global contexts.

The complete results of the Interviews with Experts can be reviewed in Appendix G1.1.1 (p.227).

4.2.2. The Community of Practice seminar: analysis of findings

The seminar was conducted during the inquirer's visit to Birmingham City University (BCU), in the United Kingdom. As detailed in Chapter 3, (p.97), the seminar comprised academics at BCU and visiting students from Mexico. The table below (Table 11) presents the main findings from the seminar.

Table 11. Findings from the Community of Practice seminar

	Curriculum themes	Curriculum markers
a	A systemic curriculum	As a philosophy, SD should be integrated into the design process.
		A Design curriculum requires that learning, teaching and assessment are interconnected.
		Experiential learning promotes not only students' SD learning, but also all stakeholders' SD learning.
b	Knowledge of sustainable development in society	ESD curricula should engage with and generate research from local contexts, at the same time as exploring the interrelationships between local and global contexts.
c	A practical curriculum	A multidisciplinary approach to SD learning.
		Experiential learning: the design of assessment methods should encourage risk taking.
		The development of students' critical thinking skills is important to investigate, through research and practice, the complexity of SD.

4.2.2.a. A systemic curriculum

The participants in the seminar agreed that SD is a philosophy and therefore ‘should be integrated into the design process' (Seminar Participant S, 2017). This led into discussion on how experiential learning and a practical approach to the curriculum promotes not only student SD learning but can involve all stakeholders in SD learning. The topic of experiential learning then prompted

discussion on assessment. In this regard, the participants identified the importance of interrelating learning, teaching and assessment and proposed that the design of assessment methods should encourage students to take risks and learn from failure.

4.2.2.b. Knowledge of sustainable development in society

The inquirer introduced the national economic, social and cultural contexts of TEC and the Curriculum Inquiry to the seminar group and a discussion followed on the importance of addressing the realities of local contexts when designing a curriculum. The group agreed that, while recognising that local and global contexts are interconnected, a curriculum should engage with its local context. For example, Seminar Participant L proposed 'generating research from our own context and taking into account what is already known at an international level' (Seminar Participant L, 2017). In this way, 'a solution that arises from a local [setting] has an impact that transcends to a global context' (Seminar Participant L, 2017).

4.2.2.c. Curriculum markers supporting a practical curriculum

The participants in the seminar proposed multidisciplinary approaches to ESD, toward better understanding how different professions perceive the same problem. This proposal informed the formulation of the following competency, to be applied to the Curriculum Interventions in Cycle 2.

> Competency # 5: The student looks for and finds knowledge inputs and expertise from other disciplines in order to meet the sustainability requirements that her/his project needs.

The relationship between multidisciplinary approaches, in the context of ESD and the complexity of SD problems, was also discussed in the seminar. This reflected the findings from the Interviews with Experts, that, 'a collaborative, multidisciplinary approach is needed to support effective SD learning' (Expert A, 2017).

The seminar group discussed the relationship between the complexity of sustainable development and the development of students' critical thinking skills. This discussion reflected the need for a SD-centred curriculum to develop students' critical reflection skills (p.66). As outlined above, the findings from the seminar informed the development of one of the competencies.

The complete results of the results of the Community of Practice seminar can be reviewed in the Appendix G1.1.2. (p.262).

4.2.3. The Nationwide Questionnaire: analysis of findings

The table below (Table 12), presents a summary of the main findings from the Nationwide Questionnaire. This was applied to fourteen universities in Mexico. The aim of the questionnaire was to develop an understanding of the status of SD in the curricula of the participants in the questionnaire.

Table 12. Findings from the Nationwide Questionnaire

	Curriculum themes	Curriculum markers
b	SD knowledge in society	The importance of local contexts and SD projects in communities.
c	A practical curriculum	The measurement of student SD learning.
		Multidisciplinary projects related to the complexity of sustainable development.
		The need to integrate SD in the curriculum more deeply.

4.2.3.a. Education for sustainable development in society

The importance of local contexts and SD projects in communities

In response to the question, which of the following sustainable development-oriented activities are promoted in your university? (Question #13 of the questionnaire, in Section III: The Educational Environment), the participants proposed student engagement in participatory design projects in communities. Overall, their responses provided evidence of an emphasis on social projects, as follows: SD projects in nearby communities (21.3%); student participation in social projects (25%) - (Appendix G.1.3, Section II, p.396), social service projects (17.5%).

4.2.3.b. A practical curriculum

The measurement of student SD learning in relation to SD

The participants in the questionnaire, were asked if there are any specific ways in which their universities measure the effectiveness of learning and teaching in relation to SD. The majority of the participants (65%) answered that they do not measure SD learning. This finding indicated an important gap in ESD in Mexico and confirmed the need for the reoriented Design curriculum to include the measurement of SD learning. In this regard, as outlined in Chapter 1 (p.18), the Tec21 Educational Model established specific expectations regarding the University's planned curricula renewal and commencing from the start of the academic year 2019-2020 (August 2019), TEC introduced the system of Competency-Based Education (CBE), as central feature of the University's new curriculum. The application of specific SD competencies in the Curriculum Interventions is outlined below (p.136).

Multidisciplinary projects

In section III of the questionnaire, which related to the educational environment, the participants were asked to select, from a list of SD-oriented activities, the ones they consider are promoted in their universities. Fourteen of the thirty participants, selected multidisciplinary projects, related to sustainable development.

The need to integrate SD into the curriculum more deeply

The Interviews with Experts (p.114) identified the need to integrate sustainable development (SD) into all higher education programmes. However, the Nationwide Questionnaire found contradictory data. That is, according to the majority of the participants in the questionnaire (70%), SD is already integrated in the curriculum (Appendix G1.1.3, p.265). However, when asked to quantify the number of SD topics in the curriculum, the participants identified that:

- in reality, SD is integrated 'only in a light way' (Appendix G1.1.3, p.265).
- the extent to which SD is integrated in the curriculum is dependent upon the disposition and profile of the teacher (Appendix G1.1.3, p.265) and that
- it is ‘included, but not formally in compulsory classes' (Appendix G1.1.3, p.265).

4.2.3.1. Summary of the main findings from the Nationwide Questionnaire

The data collected from the Nationwide Questionnaire suggests that the evaluation of SD learning in universities in Mexico is uncertain. This finding is supported by similar data collected from interviews with senior academics at TEC, as presented below (p.131).

The complete results of the results of the Nationwide Questionnaire can be reviewed in Appendix G.1.1.3, p.265.

4.2.4. The Curriculum Scoping methods at TEC: analysis of findings

The scoping methods applied at TEC narrowed the focus of the inquiry to the university's undergraduate Industrial Design programme. The undergraduate Architecture programme is in the same department as Industrial Design and the inquirer decided to conduct interviews in this discipline, as they could provide complementary data. As identified in Chapter 3 (p.77), the methods applied at TEC comprised semi-structured interviews with students, professors, directors and graduates and 'walking interviews'. The latter method provided relevant data, as it connected to the concept of the campus and any other learning environment as integral to the curriculum.

As presented in Chapter 3. (p.100), the interviews at TEC focused on exploring the participants' learning and teaching experiences, focused on ESD initiatives and practices. The table below (Table 13) presents the main findings from the interviews at TEC.

Table 13. Findings from the Curriculum Scoping methods applied at TEC

	Curriculum themes	Curriculum markers
a	A systemic curriculum, encompassing ESD in society	Design curricula change in Mexico should integrate education for sustainable development in society and in industry.
		Student engagement in design projects in communities, involving all stakeholders. provides an important way of contributing to improving ESD and thereby SD in Mexico.
c	A practical curriculum	Practitioner-led action inquiry can influence the mindsets of participants in such an inquiry, as it proceeds; in the case of this inquiry, in the context of the reorientation of the curriculum.
		A practical approach to ESD requires the development and application of tools to measure SD learning.

4.2.4.a. A systemic curriculum, encompassing ESD in society

The findings from the Curriculum Scoping progressively justified the model of SD and ESD as mutually supportive and interdependent model (Haaz, 2019; UNESCO, 2012, pp.36-114). Therefore, the theme of a systemic curriculum

began to be seen as encompassing ESD in society; addressing the need for ESD to actively contribute to increasing SD knowledge in society. In this context, the interviews at TEC identified the need for the reoriented curriculum to increase participatory design projects in communities. As a reminder to the reader, it is worth restating, as highlighted in Chapter 1, (p.23), that a barrier to SD in Mexico is that the country has 'the lowest number of higher education students among the OECD countries' (Expansion, 2017).

External projects: a marker for the reoriented Industrial Design curriculum
The Industrial Design Project courses include external projects. Through the professional connections of the Design professors, these courses promote collaborations with external organisations as training partners. Resonating with the finding from the interviews at TEC, the Tec21 Educational Model requires that the university's curricula formally include external projects. This university-wide curriculum development is outlined in more detail below as part of the synthesis of findings from the Curriculum Scoping (p.131).

As presented in Chapter 3 (p.105), the Curriculum Interventions were undertaken in the Project courses as they enabled the students to integrate the knowledge and skills that they had developed through other courses to their design projects.

4.2.4.b. A practical curriculum

As identified in Chapter 2 (p.69), the reorientation of a curriculum concerns knowledge content, cognitive processes, and personal development. In this regard, when the inquirer conducted an interview with one of the professors, in preparation for the interviewee's participation in the Curriculum Interventions, the conversation influenced his approach to including sustainability in the curriculum. Based on the findings from the inquiry, the interview discussed the inclusion of SD in the Project courses (the courses selected for the Curriculum

Interventions). The professor was open to change and adjusted the curriculum plan for his Project course. The inquirer proposes that this finding provides evidence of:

- how approaches to teaching a curriculum can be variable as they depend on the mindsets of professors and
- an example of how practitioner-led action inquiry can result in encouraging and facilitating curriculum change, during a case study.

The inquirer proposes that this possibility is transferable to any element of any curriculum.

The interviews with senior academics at TEC identified a lack of tools to measure SD learning in Mexico and in Spanish (Expert D; Expert K). The formulation of specific SD competencies, within the Tec21 Educational Model, contributes to filling this gap in SD pedagogy, in Mexico.

The complete results of the results of the methods applied at TEC can be reviewed in Appendix G1.1.4. Results of the methods applied at TEC (p.280).

4.2.5. Synthesis of findings from the Curriculum Scoping (Cycle 1)

The table below (Table 14) presents the theme of a systemic-practical curriculum, interrelating the previously separate themes of a systemic and practical curriculum. This adjustment gave greater emphasis to the interdependence between the theory of a systemic curriculum and the realities of practice. The inquiry informed the development of a range of curriculum markers, with the aim of increasing opportunities for the students to explore design projects through critical inquiry, as an evolving subject: subject to the possibilities of new interpretations and adapting to different environments. The pedagogical instruments, informed by the Curriculum Scoping, in combination

with the Literature Review, are presented below (Table 14) and outlined further in section (4.2.5.1.).

The application of SD competencies in the Curriculum Interventions demonstrated the effective translation of the educational system of CBE, into the practice of a curriculum.

Table 14. Synthesised findings from the Curriculum Scoping, all methods, in combination with the Literature Review:

Synthesised curriculum theme	Pedagogical instruments, integrated into all areas of the curriculum
A systemic-practical curriculum	SD competencies; encompassing SD content, cognitive processes and personal development.
	External projects, guided by collaborative and participatory approaches to ESD and the need to engage with local/global realities.
	International student competitions, enabling students to explore a wider range of Design/SD perspectives.
	Flexible online learning and teaching resources.
	Multidisciplinary student projects.

4.2.5.1. A systemic-practical curriculum

The main findings from the Curriculum Scoping, in combination with the Literature Review, progressively informed the development of the theme of a systemic and practical curriculum and markers (learning and teaching methods and approaches) for the reoriented Industrial Design curriculum.

As identified above, the Literature Review informed the model of SD and ESD as mutually supportive and interdependent (p.129). The Interviews with Experts similarly emphasised the importance of achieving the alignment of all stakeholders in SD, with universities providing a 'common arena' (Expert A, 2017). Overall, the Curriculum Scoping found that universities, in general and in the ESD context of this inquiry, must increase their efforts to contribute to education for sustainability in society.

The development of curriculum markers, integrated into all areas of the curriculum, was guided by the complexity and evolving nature of design and SD (pp.12-38) and how this requires approaches to the curriculum, which promote and enable the exploration of all aspects of design and the subject of SD, through research and development, as a continuing process (p.16).

4.2.5.1.a. The development of SD competencies for the Curriculum Interventions in Cycle 2

The Nationwide Questionnaire identified the need for the new Design curriculum to include the measurement of SD learning. At the time of the questionnaire, TEC was planning to implement Competency-Based Education (CBE) as a central feature of its university-wide Tec21 Educational Model / curriculum review (p.127). This timing enabled the inquiry to develop SD competencies for the Curriculum Interventions in Cycle 2, in advance of the university's formal implementation of CBE. The following findings from the Curriculum Scoping, combined with the Literature Review informed the formulation of the SD competencies. The SD competencies are presented below (p.138).

4.2.5.1.b. External projects

The scoping of the curriculum, complemented by the Literature Review, found that the reoriented curriculum should encompass knowledge content and leaning and teaching methods, capable of promoting sustainability through experiential learning, inside and outside the university and external projects, involving companies, organisations and communities. This approach is aligned to the professional paradigm of TEC and to the university's decision to increase external projects, as part of the Tec21 Educational Model.

4.2.5.1.c. International student competitions

As highlighted in Chapter 1 (p.25), in 2017-2018, TEC's Industrial Design students participated in the Royal Society of Arts (RSA) Student Design Awards competition. One of the motivations behind this inquiry was to help to broaden the Industrial Design students' knowledge of different international design contexts and perspectives (p.26). Each year, the RSA invites university departments, participating in the Student Design Awards, to suggest future project contexts and challenges. As part of including the RSA competition in the Industrial Design curriculum at TEC, in 2018, the Department of Architecture invited the Director of the RSA to provide a student workshop. In addition to helping to broaden the students' learning experience, this initiative contributed to developing an important collaborative network (pp.71-73).

4.2.5.1.d. Flexible online resources

The scoping of the curriculum found that because of the contested and evolving nature of SD, the reoriented Industrial Design curriculum should include a range of learning and teaching methods, enabling the students to

explore their design projects in personalised and flexible ways (p114). This finding contributed to informing the creation an online SD learning resource, as one of the research methods for this inquiry. Chapter 5 outlines the development of this resource.

4.2.5.1.e. Multidisciplinary student projects

The first year of TEC's undergraduate curricula include courses, involving multidisciplinary learning and teaching. These courses enable the students to broaden their knowledge of different university disciplines before specialising in their chosen discipline. The Community of Practice Seminar proposed that multidisciplinary approaches to ESD can better enable students to develop their understanding of how different professions perceive the same problem (p.122). This finding from the seminar suggested that the reoriented curriculum should increase the inclusion of multidisciplinary projects.

4.2.5.2. The adjustment to the research question

As described at the end of Chapter 2 (p.33), the review of the literature on the relevant discourses, led to adjusting the original research question. The original question was:

> In what ways can innovations in Design education, for sustainable development, contribute to developing 'relevant learning objectives and learning contents' towards achieving the 'quality education goal' of Mexico (PND 2013).

The second iteration of the question replaced *innovations* with *curriculum change* and included research objective 1.

In what ways can curriculum change, with the objective of integrating sustainable development into the Industrial Design curriculum, contribute towards achieving the 'quality education goal' of Mexico (PND 2013)?

4.3. The Curriculum Interventions, Cycle 2: results and analysis

As highlighted in the Literature Review (p.59), specific SD competencies were formulated to be applied, in combination with Student Course Surveys, to the interventions. In this way, together with relevant content, the Curriculum Interventions integrated SD into the Project courses of the Industrial Design and Architecture curricula. The surveys enabled the interventions to collect and analyse data on the students' perceptions of their development of the competencies, resulting from the interventions. The section below (4.3.1.) presents the five SD competencies developed for the interventions and outlines the process of their formulation. This is followed by sections, which provide an overview of the interventions (4.3.2.), analyses of the main findings from Student Course Surveys (4.3.3.) and a synthesis of findings from the interventions (4.4.).

The majority of the students who participated in the Curriculum Interventions were the same throughout their three iterations. Analyses of the results of the Student Course Surveys are presented in the subsections below, 4.3.3. and 4.3.4. Following the first (Trial) intervention, the inquirer interviewed the Architecture professors to explore their reflections on their experiences of the interventions. This enabled the next Student Course Survey to be adapted for the second intervention. This section concludes by presenting a summary of the main findings from the Student Course Surveys / Curriculum Interventions and how they informed the development of curriculum themes and markers for the reoriented Industrial Design curriculum (named Design from August 2019).

4.3.1. The development of competencies for the Curriculum Interventions

The Literature Review identified that competencies:

- are 'suited to practical learning experiences' connected to a profession (Turcio & Palacios, 2015); Guzman 2003, p.145)
- promote the development of a 'set knowledge, skills and attitudes' (Guzman 2003, p.145)
- enable the measurement of SD learning and teaching and can be formulated to
- encompass knowledge, skills and personal competencies, in accordance with the principles and practice of social design and design education for sustainable development (Frank & Stanszus, 2019)

As identified in Chapter 2 (p.58), TEC introduced Competency-Based Education (CBE) from the start of the academic year 2019-2020 (August 2019), as a core feature of the University's Tec21 Educational Model. Therefore, the development of disciplinary SD-oriented competencies for the interventions was aligned to the University's new educational model.

The interventions applied the following set of five competencies to the 2011 and the 2017 curriculum.

Table 15. The five competencies informed by the Curriculum Scoping

The five competencies, informed by the scoping of the inquiry	
1	The student´s work demonstrates knowledge and understanding of SD locally/globally.
2	The student's work demonstrates a mindset change in relation to SD through the successful application of the SD principles to her/his projects as well as in her/his own lifestyle.
3	The student assesses the life cycle of the product/s of her/his projects based on criteria that relate to the minimisation of the multiple environmental impacts throughout the cycle.
4	The student encourages the rest of the group´s involvement in SD when presenting her/his projects to the group.
5	The student looks for and finds knowledge inputs and expertise from other disciplines to meet the sustainability requirements that her/his project needs.

The 2011 and 2017 Industrial Design curriculum comprises nine semesters. All three Curriculum Interventions were applied to the Industrial Design Project courses. These courses operate consecutively from the third to the ninth semester. The Project courses were selected for the interventions as their transversal design enables the students to apply the knowledge and skills they have developed across all other elements of the programme, to these courses. The Industrial Design curriculum can be reviewed in the Appendix A, p.209.

Complementing the findings from the Curriculum Scoping and the Literature Review, the recommendations of the following senior academics at TEC contributed to the development of the competencies.

1. A professor (Puebla campus), who leads the 2019 study plan design team for the undergraduate Architecture programme and provided expertise in forming the Tec21 Educational Model and the University's generic competencies.

2. An Industrial Design professor (Puebla campus), who is a graduate of the undergraduate Industrial Design programme at TEC and who holds a Master's degree in sustainability from the University of Sussex, United Kingdom.

3. The Director of the Industrial Design Academic Department (Puebla campus).

After formulating the specific SD competencies, the inquirer discussed the findings from the Curriculum Inquiry with the Director of the Industrial Design Academic Department. Based on a recommendation of the Director, the inquirer met with the professors, who would be teaching the Industrial Design Project courses in the Fall semester of 2018, to explore and negotiate ways of including SD content and assessment criteria (the five competencies) in their courses. The inquirer's original request was to apply the SD competencies to the Project courses in the Spring semester of 2019. However, the Director of the Industrial Design Academic Department, considered it highly relevant to the development and application of the Tec21 Educational Model, across the University’s curricula, to begin the interventions, with the use of competencies, as soon as possible.

In addition to the contributions from the senior academics at TEC, a 'Roadmap for Integrated Sustainability', an initiative developed by the United Nations Global Compact to implement universal sustainability principles to support UN goals, was also considered in formulating the competencies (United Nations Global Compact, date accessed 02/01/2019).

4.3.2. Overview of the Curriculum Interventions

In preparation for the implementation of the interventions, the inquirer presented the findings from Cycle 1 and the five SD competencies to the professors who would be participating in the interventions. This was followed by discussion on the possible ways in which the professors could include SD content and assessment criteria in their courses. In a number of cases, this led to the professors rethinking their perspectives on the connections between their specialist subjects and SD. In one case, the inquirer observed that for a subject without an obvious connection to SD, within the existing curriculum, the professor was open to adjusting the course to include aspects of SD content. This finding provides evidence of how practitioner-led action inquiry can influence change, during the inquiry.

As introduced above, the first (Trial) and second interventions were implemented in the Fall semester of 2018 (Trial) and the Spring semester of 2019 (second intervention) to the Industrial Design programme, at the Puebla campus. The use of the five competencies in the Trial intervention was the first application of competencies at TEC.

The third intervention was implemented in the Industrial Design and Architecture programmes in the Fall semester of 2019 and then the Spring semester of 2020, also at the Puebla campus.

All three Curriculum Interventions used the following methods:

- The inclusion of SD curriculum content and competencies;
- Student Course Surveys: conducted at the end of the semesters, in which SD content and competencies had been included;
- The Student Course Surveys asked the participating students to assess their development of SD learning, in relation to the five competencies.

The Student Course Surveys used a 1 to 5 scale, 1 representing the lowest level and 5, the highest level. Appendix F, p.225, provides information on the format of the surveys.

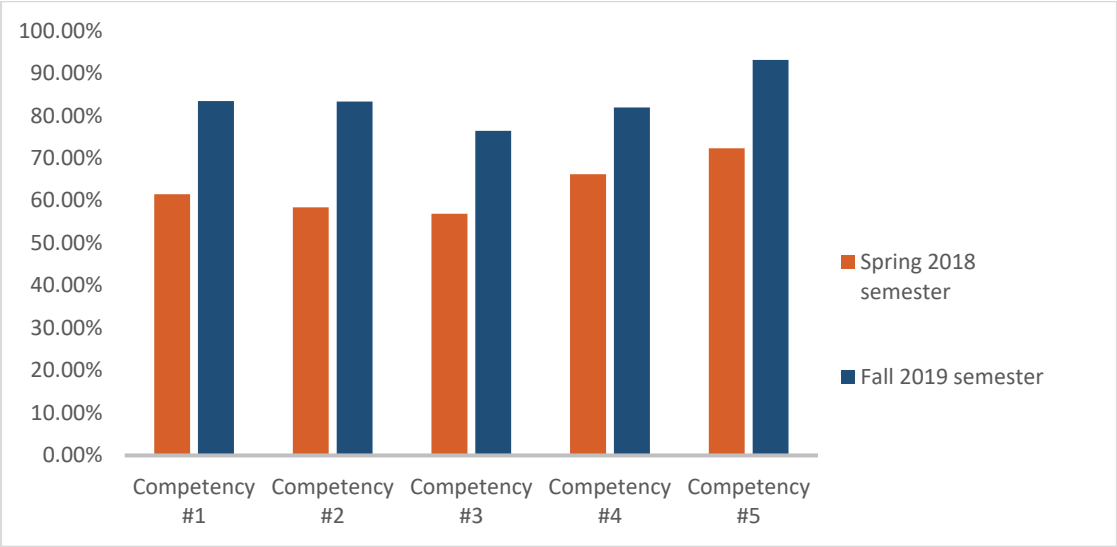
4.3.3. The Curriculum Interventions - Student Course Surveys

The Trial Student Course Survey asked the Industrial Design students to compare their development of the competencies between two semesters: the semester without SD in the Project courses (Spring semester, 2018) and the semester with SD included in the Project courses (Fall semester, 2018). The results and analysis of the Student Course Surveys are presented below (4.3.3.1. to 4.3.3.3.).

4.3.3.1. Trial Curriculum Intervention - Student Course Survey: results and analysis

The Trial intervention was applied to the seven Industrial Design Project courses. The table below (Table 7) compares the students' self-evaluations of their development of the five competencies between two semesters: the semester with SD included in the courses (represented by the blue columns) and the semester without SD included in the courses (represented by the orange columns).

Table 16. Results of the Student Course Survey: Trial Curriculum Intervention



The participating students were asked to evaluate their development of the five competencies. The table above shows that, as a result of the Trial Curriculum Intervention, the students recognised advances in their SD learning. The inquirer considers that this provides comprehensive evidence that when SD content is explicitly included in the curriculum, students are more likely to develop their knowledge of the subject. Although the table also shows that the results for Competency #4 and Competency #5 are at the highest levels, the competency with the greatest advance was Competency #2:

> Your work demonstrates a mindset change in relation to SD, through the successful application of SD principles to your projects as well as in your own lifestyle.

This result is significant as it supports the need for the reoriented Industrial Design curriculum to encourage the development of 'growth mindsets' (Dweck et al., 1999 cited in Limeri et al., 2020, pp.1-2); in the case of this inquiry, guided by the new design paradigm (Stebbing, 2015, p.10).

Reflecting on their experience of the first intervention, the majority of the participating Industrial Design professors and students, reported to the inquirer that they needed more SD information to inform the content and projects of their courses. This finding emphasised the need for the research to address this specific resource deficiency. The participants also identified that the courses would benefit from more SD information resources in Spanish to support ESD at TEC and other Spanish speaking universities and communities. Chapter 5 is dedicated to the unplanned activities of the study. Chapter 5 describes the development of Sostek. As introduced in Chapter 1 (p.32), Sostek responded to the need to create an online SD learning resource, initially for the Industrial Design students and professors at TEC. Chapter 5 also outlines related communications activities, which in combination with Sostek, intended to build SD resources for Spanish speaking communities and to share the results of the research (in Spanish and English languages) with others, nationally and internationally.

An adjustment to the survey method resulted from this first (Trial) intervention. The inquirer decided that for the following interventions, the students would be asked to accompany their evaluations with comments and supporting evidence. It was considered that that this would enrich and complement the quantitative data collected.

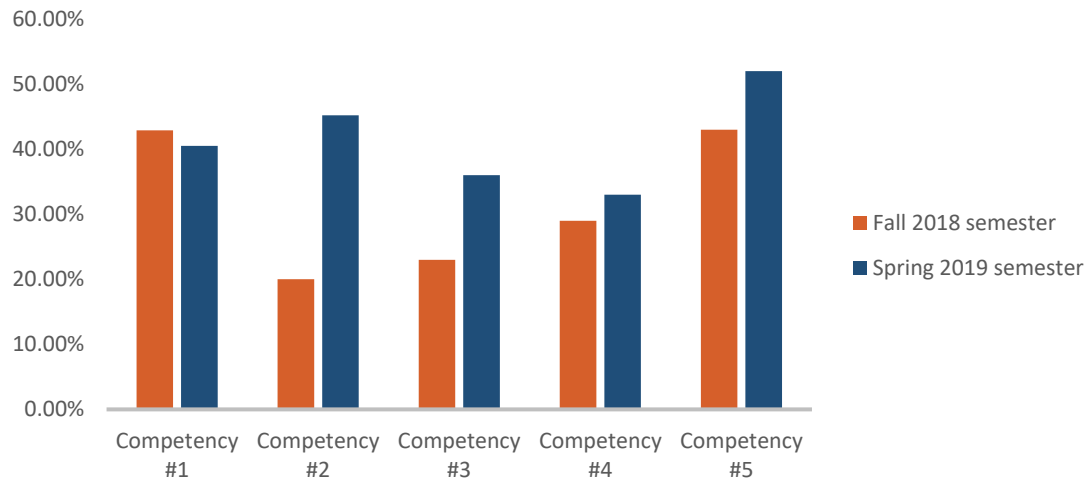
The complete results of the Student Course Survey for the Trial Curriculum Intervention can be reviewed in the Appendix G1.2 Curriculum Inquiry Cycle 2 Results, p.314.

4.3.3.2. The Student Course Survey - second Curriculum Intervention: results and analysis

This intervention was again applied to the seven Industrial Design Project courses. The table below (Table 7) compares the students' evaluations of their

development of the five competencies: it compares the semester without SD included in the courses (represented by the orange columns) and the semester with SD included in the courses (represented by the blue columns).

Table 17. Results of the Student Course Survey: second Curriculum Intervention



The results for this survey show advances in the students' development of four of the five competencies. However, the advances are lower than they were for the Trial intervention. The inquirer considers that this was because, in the Trial intervention, the students experienced a Project course with SD content and competencies included, for the first time. While showing lower advances, the results for the second intervention still provide evidence that the students continued to recognise advances in their development of SD learning.

> Competency #1: Your work demonstrates knowledge and understanding of sustainable development issues locally/globally.

This is the only competency showing a lower level than the in the first intervention. The lack of an advance for this competency indicates that continuous curriculum research and development is needed to improve ESD.

The result for Competency #2, which asked the students to evaluate their development of mindsets in relation to sustainable development, shows an even greater advance than the result for the same competency in the Trial intervention. This second advance further supports the need for the reoriented Industrial Design curriculum to encourage personal development; in the context of this inquiry, with an emphasis on 'growing growth mindsets' (Dweck et al., 1999 cited in Limeri et al., 2020, pp.1-2), guided by the paradigm of ESD (see p.36 in the LR).

The complete results of this second Student Course Survey can be reviewed in the Appendix G1.2. Curriculum Inquiry Cycle 2 Results, p.314.

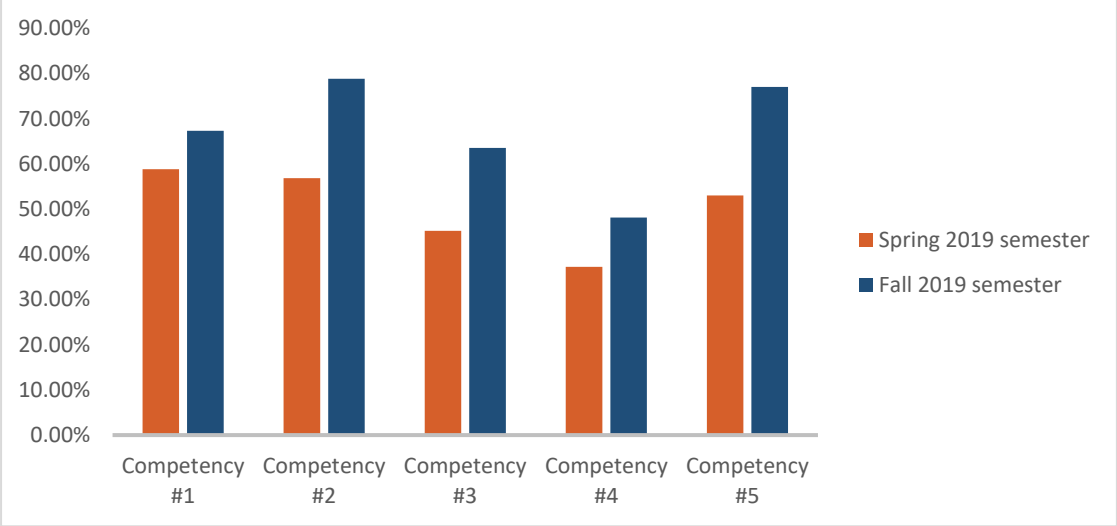
4.3.3.3. The Student Course Survey - third Curriculum Intervention: results and analysis

This third intervention was applied for the first time to the Architecture Project courses as well as to the Industrial Design Project courses. It is important to note that the Architecture curriculum includes two SD subjects: Bioclimatic Design and Building and Energy Efficiency and in general, because of the professional requirements of Architecture, SD content must be included in all Architecture curricula. By comparison, the Industrial Design curriculum currently has no formal SD subjects and any connections to SD content are communicated in less formal ways than in the Architecture programme.

The participation of the Architecture Project courses in the interventions highlighted that, compared to the Industrial Design Project courses, the inclusion of SD information resources in the Architecture courses was more developed. This finding reinforced the need, as discussed above in relation to the first intervention (p.141), to fill the gap in SD information resources for Industrial Design students and teachers.

Industrial Design: The table below (Table 8) compares the students' self-evaluation of their development of the five competencies, between the Spring and the Fall semesters of 2019. The semester without SD included in the courses is represented by the orange columns and the semester with SD included in the courses is represented by the blue columns.

Table 18. Results of the Student Course Survey: third Curriculum Intervention (Design)



Overall, the results of this survey provide evidence that the students evaluated advances in their development of the five sustainable development competencies, from the previous intervention in the Spring semester of 2019 to the Fall semester of 2019.

The highest levels and greater advances were for Competency #2 and Competency #5:

> Competency #2: The student's work demonstrates a mindset change in relation to SD through the successful application of the principles of SD to her/his projects as well as in her/his own lifestyle.

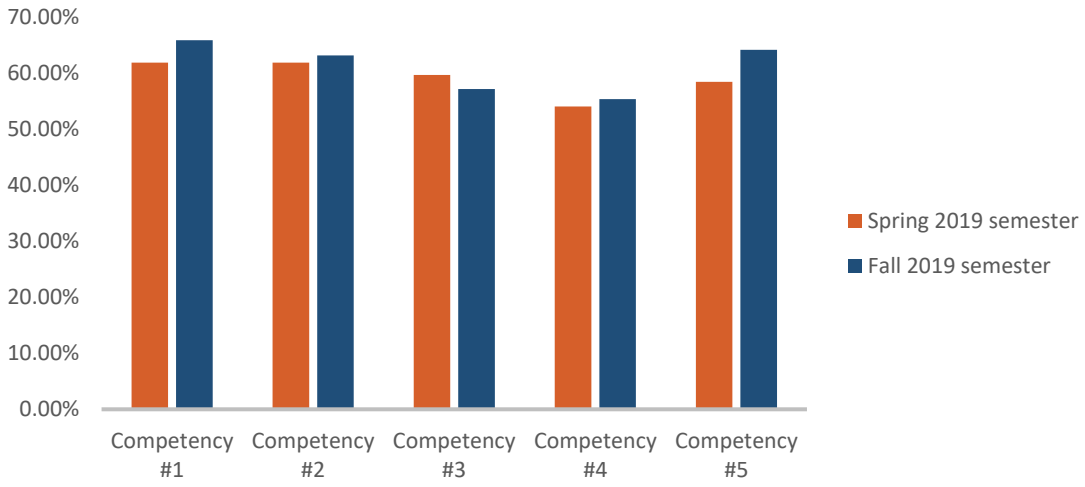
Competency #5: The student looks for and finds knowledge inputs and expertise from other disciplines to meet the sustainability requirements that her/his project needs.

These levels and advances for competencies #2 and #5 are comparable to the results from the two previous surveys, indicating that the students' SD learning developed particularly strongly in relation to the competencies connected to personal development and collaborative, multidisciplinary approaches to SD.

The complete results of this second intervention to the curricula can be reviewed in the Appendix G1.2 Curriculum Inquiry Cycle 2 Results, p.314.

Architecture: The table below (Table 19) compares the students' self-assessment of their development of the five competencies, between the Spring and the Fall semesters of 2019. The semester without SD included in the courses is represented by the orange columns and the semester with SD included in the courses is represented by the blue columns.

Table 19. Results of the Student Course Survey: third Curriculum Intervention (Architecture)



The Fall semester, 2019, was the first semester in which the intervention was applied to the Architecture Project courses.

Overall, across the five competencies, the results of this survey show an even distribution of levels and small advances and decreases of levels between the two semesters. The inquirer considers that these results reflect the fact, as highlighted above (p.145), that SD content and pedagogy is more advanced in the Architecture programme, as SD is a professional requirement in Architecture programmes.

4.3.3.4. Interviews with professors, following the Curriculum Interventions: Architecture and Design

Following the Student Course Survey applied to the Architecture Project courses, the inquirer interviewed the participating Architecture professors in the interventions to explore their reflections on the students' development of the five SD competencies. Open questions were used to prompt discussion on their experiences of the interventions, enabling comparison between the students' and Architecture professors' reflections on the interventions. The professors were also asked to share with the inquirer the curriculum content and any additional material that they had used in the Project courses.

4.3.3.5. Conclusions to the Student Course Surveys - Curriculum Interventions (Cycle 2)

The Student Course Surveys provided evidence that through the interventions, the students recognised advances in their SD learning. In particular, the results showed that the Trial intervention had the greatest positive impact on the participants SD learning. The inquirer considers that this impact was likely to have been affected by the students experiencing, for the first time, the

explicit inclusion of SD in the curriculum. That is, the more explicit presence of SD in the Project courses encouraged the students to reflect on their learning with a greater focus on SD contexts.

As presented above (p.142) the surveys also found that the highest levels and most marked advances were for Competency #2 (p.142) and Competency #5 (p.146). These competencies concern problem-based learning, personal development and collaboration (Jacoby et al., 1996). While recognising that research-based interventions are likely to influence the perceptions of the participants in the research, the inquirer argues that without advancing SD learning through research, SD cannot be improved. Overall, the students' advances in SD learning, as measured by the five competencies, provide evidence that Curriculum Interventions contributed to improving SD learning and teaching. Therefore, the inquirer proposes that further research is needed to support continuous advances in ESD.

A related finding from the interventions was that, through their SD focus, the students and professors became more conscious of what was missing from the curriculum and identified elements of the Project courses, which could be introduced and / or improved upon. As highlighted above (p.85), this resulted in the creation of an online learning space as a curriculum resource; to promote SD competencies and to generate online SD materials and different learning and teaching tools.

The Curriculum Interventions found that:

- the achievement of fundamental curriculum change requires a process of continuous research and incremental development
- encouraging and creating the means of supporting developing SD mindsets, through ESD curriculum research and development, is essential to achieving effective student SD learning (Expert U, 2017).

As identified above (p.128), the results from the methods applied at TEC demonstrated that approaches to teaching the curriculum can be variable as they depend on the mindsets of professors, as well as on the written curriculum. In this regard, the inquirer found that a conversation with a professor highlighted the potential for practitioner-led action inquiry to promote reflection and thereby the mindset of a participant in an inquiry, in the case of this study, toward reorienting the curriculum.

Following the Curriculum Interventions (January 2021), the inquirer was invited to present the findings from the inquiry to participants in a nationwide course (CADi) at TEC. The purpose of these courses, which are supported by expert guests, is to update professors on significant educational and professional developments, relevant to the university. The inquirer collaborated with an external expert to provide updated information and resources on the implementation of sustainability approaches for higher education Design programmes. This informed the development of a curriculum framework for all TEC's undergraduate Design programmes, taught across ten campuses.
The inquirer proposes that the university's adoption of the framework, informed by the Curriculum Interventions, contributed to achieving the overall research objectives of integrating SD into TEC's Industrial Design curriculum (overall objective 1) and into the university's educational initiatives, enabling the continuous development of the curriculum (overall objective 2).

4.4. Synthesis of the Curriculum Inquiry findings (Cycle 1 and Cycle 2)

The diagram below (Figure 3) presents a curriculum framework, informed by the synthesis of the main findings from cycles 1 and 2 of the Curriculum Inquiry, in combination with the Literature Review. The theme of a systemic and practical curriculum, encompasses:

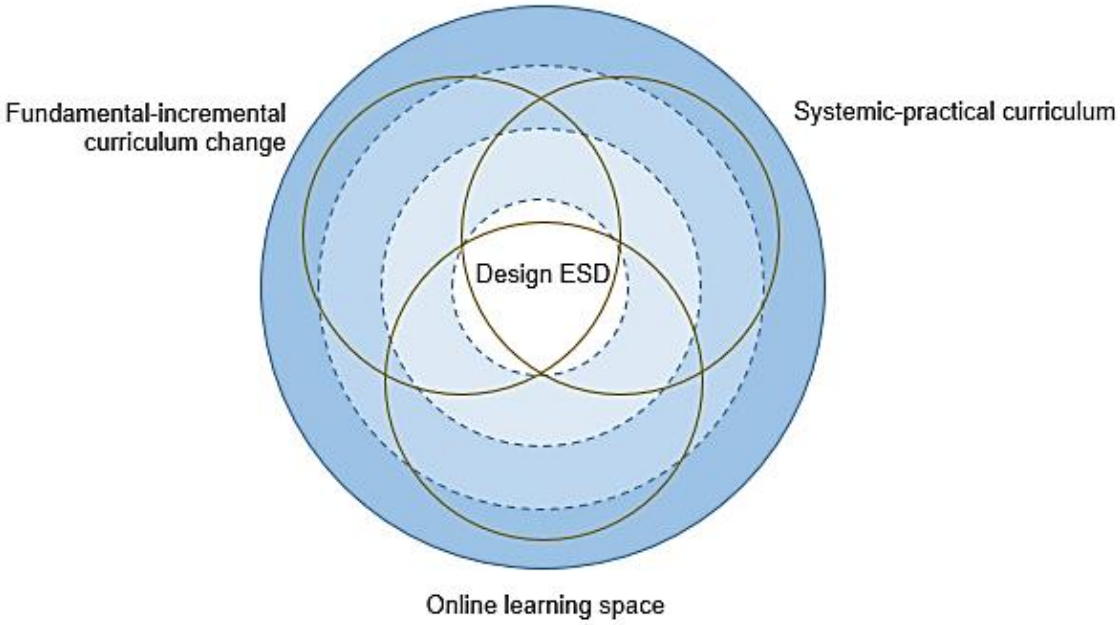
- SD-ESD curriculum markers: encompassing content and a range of learning and teaching methods, including learning in different environments
- a process of continuous incremental curriculum development, supporting fundamental change
- The creation of an online learning space

The theme of a systemic-practical curriculum promotes the translation of educational theory into the realities of the design project and the practice of sustainability. The selected methods, as presented above (p.128), support the students' SD learning: their range addresses the broad scope of existing and potential SD learning situations and contexts, involving different perspectives and environments.

One of the practical methods was an unplanned activity from Cycle 2, the Curriculum Interventions. The experiences of the participants in the interventions led to the creation of an online learning space. The momentum to provide a range of SD tools and information sources, through this development, increased as new possibilities were identified through the practice of the study. Also, it's significance for the research grew, as the space began to be used and further developed. This momentum led to dedicating a chapter (the next chapter) to the unplanned activities from the inquiry.

The process of continuous curriculum development is supported by incremental steps and new initiatives, informed by further ESD research and practice, as the reoriented curriculum and the subject of design and SD evolves.

Figure 3. A framework, informed by the Curriculum Inquiry (Cycles 1 and 2)



4.4.1. A systemic-practical curriculum

Cycles 1 and 2, in combination the Literature Review, identified that a systemic and practical approach should provide a foundation for new Design ESD-centred curriculum at TEC. This approach was informed by the following findings:

- a mutually supporting SD-ESD model (UNESCO, 2012; Haaz, 2019) is best suited to promoting the engagement of all stakeholders in SD, in SD learning and contributing to enabling all stakeholders to benefit from the curriculum.
- the sustainable development of Mexico requires the alignment of all stakeholders in SD, with universities acting as a 'common arena' for the subject (Expert A, 2017)
- the design project functions within 'complex systems'. Therefore, a systemic approach to design to address the challenges of sustainability (Findeli, 2000; Iniguez, 2016; Stebbing, 2015) - (p. 47)
- the participation of multiple stakeholders allows for different groups in society to engage in generating the curriculum (pp.17-39-61)

4.4.2. Curriculum markers for the reoriented curriculum

The inquiry found that ESD requires the capability of a curriculum to promote, support and measure students' SD learning.

The results of the Student Course Surveys demonstrated that the students, who participated in the Curriculum Interventions; with SD content and competencies explicitly integrated into the Project courses, recognised their development of the SD competencies, informed by the inquiry.

The use of SD competencies in the Curriculum Interventions enabled the students to recognise and evaluate their SD learning and the professors to measure the development of the students' SD learning, resulting from more formally including SD in their Project courses.

Multidisciplinary working groups and collaborative innovation (Krstikj 2021) supports students in searching for and finding knowledge for their design projects. This finding informed the development of Competency #5: The

student looks for and finds knowledge inputs and expertise from other disciplines to meet the sustainability requirements that her/his project needs.

4.4.3. Supporting fundamental change through a process of continuous incremental curriculum development

The findings from the inquiry reinforced the inquirer's view, formed during the reconnaissance period of the research, that fundamental curriculum change would be needed to fully integrate SD into the Industrial Design curriculum and that this level of change would require a process of continuous incremental development (p.70).

The Literature Review discussed the complex, contested and evolving nature of SD, arguing that given this instability, before integrating SD into the curriculum, the scope and realities of the subject should be explored. Based on the developing findings from the inquiry, this conclusion was extended by proposing that the integration of SD into the curriculum requires a process of continuous research and development, to inform adaptations, as the design project and SD evolve over time (p.58).

As highlighted earlier (p.136), the Curriculum Interventions involved discussions with a professor, which led to identifying ways of integrating SD into the curriculum. This provided an example of practitioner-led action inquiry influencing change, during the inquiry. The inquirer proposes that this research approach is well suited to educational practice, as it enables all stakeholders in the research, irrespective of their disciplines and/or levels of SD knowledge, to engage in improving ESD, as a continuous process.

4.4.4. The online SD learning space (Sostek)

One of the specific objectives of this inquiry was to create innovative learning methods and to develop an understanding of how they can support the new Design curriculum at TEC (p.16). As Introduced in Chapter 1 (pp31-32.), the creation of Sostek responded to the first curriculum intervention, which found that the participating students and professors needed more SD information resources to support their projects. Chapter 5 describes how this initiative was built upon as an integral pedagogy for the interventions and the new Industrial Design curriculum, as new findings and SD learning possibilities emerged, and as a not-for-profit SD space for other Spanish speaking universities and communities.

4.5. The reformulation of the SD competencies

Informed by continuing critical reflection on findings from scoping of the curriculum (Cycle 1), in combination with the Literature Review, following the intervention, four of the five SD competencies were adjusted. The adjustments responded to new interpretations of the concepts underlying the original formulation of the competencies. The table below (Table 16), presents the first iteration of the SD competencies (formulated in Cycle 1 for the interventions) and the adjusted competencies (second iteration, following the interventions). The italicised text identifies the adjustments made to the first iterations of the competencies.

Table 16. (a)

SD competency #1: first and second iterations	
First iteration	The student´s work demonstrates knowledge and understanding of SD locally/globally.
Second iteration	The student´s work demonstrates a developing knowledge and understanding of sustainable development *contexts, concepts and practices.*

Competency #1 was reformulated to give more emphasis to the process of developing knowledge, to leave more open the SD contexts within which SD is developed and to add knowledge of SD concepts and practices.

Table 16. (b)

SD competency #2: first and second iterations	
First iteration	The student's work demonstrates a mindset change in relation to SD through the successful application of the SD principles to her/his projects as well as in her/his own lifestyle.
Second iteration	The student's work evidences a *developing* mindset in relation to SD through the successful application *of thinking processes in solving design problems.*

Competency #2 was reformulated to increase its focus on the student being able to evidence a developing SD mindset through applying critical skills in solving design problems.

Table 16. (c)

SD competency #3: first and second iterations competency	
First iteration	The student assesses the life cycle of the product/s of her/his projects based on criteria that relate to the minimisation of the multiple environmental impacts throughout the cycle.
Second iteration	The student assesses *her/his design projects, based on developing* criteria, *determined by maximising the sustainability of products and services.*

Competency #3 was revised to encompass the broader and variable aspects of SD and to encourage the assessment of design projects, based on developing, rather than fixed sustainability criteria.

Table 16. (d)

SD competency #4: first and second iterations competency	
First iteration	The student encourages the rest of the group´s involvement in SD when presenting her/his projects to the group.
Second iteration	The student encourages *participatory approaches to presenting project ideas and solutions in group and collaborative project situations.*

Competency #4 was reformulated to give more emphasis to participatory and collaborative approaches.

It is worth noting that competency #5 did not change.

> The student looks for and finds knowledge inputs and expertise from other disciplines to meet the sustainability requirements that her/his project needs.

The above findings informed the design of the presentation for the Focus Groups and the list of questions for each group (professors, students, and external guests, in Cycle 3).

4.6. Focus Groups: validation of the outcomes of the curriculum inquiry

The Focus Groups involved taking the main findings from the inquiry back to the participants in the Curriculum Interventions and to the external guests who had contributed to the Curriculum Scoping in Cycle 1. As described in the research methodology chapter (p.106), an interviewer presented the findings from the inquiry to each group. The interviewer then asked the participants a series of open questions, designed by the inquirer, to prompt discussion and elicit from the interviewees their opinions and viewpoints on the findings. Seventeen interviewees participated in the Focus Groups. The next sections (4.5.1.- 4.5.4.) provide summaries of the data collected from each group. The selection of data intends to represent, the range of the participants' opinions and viewpoints as accurately as possible. The location of the Focus Groups was the Gesell chamber of the Puebla campus. After presenting the findings to each group, the inquirer transcribed the data collected.

In addition to questions focused on the Curriculum Interventions, each group was asked to comment on one of the unplanned activities from the inquiry, the development of the online learning space. The data collected from the Focus Groups on this initiative is presented in the next chapter (Chapter 5, p.169), which is dedicated to the unplanned outcomes of the inquiry.

4.6.1. The Focus Group with students

The students were asked to reflect on the following three questions:

Q1: Have you learnt anything about sustainable development in the last three semesters?

1.1. If you have learnt something, what have you learnt?
1.2. In which subjects did you learn about sustainable development?
1.3. Who was involved and what contexts did the learning take place?
1.4. Can you say what it was that made a difference to how you think about sustainable development in relation to design practice?

Q2: Can you give examples of projects in which you applied what you had learnt or began to think about how you could do this?

Q3: What do you think you can apply in your practice as a designer - that is different from how you thought about design practice before the last three semesters?

A student recognised that she had 'learned more about sustainability' in the semester with the curriculum interventions, compared to the semesters', without the curriculum interventions (Q1.CI.7, 2020). The student described a project in which the students addressed (or learned about) the problem of the Atoyac River pollution in the area of Puebla and were encouraged to 'think about the future of the product that we designed; what will happen to the product when its useful life ends (Q1.CI.7, 2020). This provides an example of how in general, the students commented on how the professors set sustainability problems, provided guidance on sustainability and reinforced the urgency of solving sustainability problems. For example, a student asserted that sustainability 'should no longer be optional' (Q1.CI.7, 2020); another student described a project in which the group 'developed a collection

campaign' to promote knowledge of sustainability in society (Q2. CI.7, 2020) and in relation to a student's participation in an international student design competition, the student reflected on how the 'circular economy' focus of the project 'forced us to investigate these issues, because we didn't know them before' (Q2. CI.8).

When asked to consider the influence of their experience of the interventions on their approach to design practice (Q3), a student commented on an aspect of a project that she had experienced before the interventions. The student identified an element that, in her opinion, was missing from the design of the project (Q3.SC.9, 2020). The project involved the use of a non-reusable material, but the project did not include information on the possible uses of any un-used material at the end of the semester. The student highlighted that 'the janitors throw everything away at the end of the semester; [the material] is not recycled' and proposed that:

> homework should be designed so that in the end, you can have it as a decoration at your house or something you can give as a gift, not something you have to throw away because it is useless. (Q3.SC.9, 2020)

The student's thinking exemplifies the need, as discussed in Chapter 2 (p.38), for a systemic approach to ESD curriculum design and in this case, how this approach can work in practice. The student's account of the project supports the findings from the inquiry, that elements of a systemic and practical Design ESD curriculum should involve the participation of all stakeholders in SD, sustainability should permeate all elements of a project and projects should be designed to work inside and outside the University.

A student in the ninth semester, who therefore had not participated in the Curriculum Interventions, reflected on how 'the design teachers are requiring sustainability from the students in the project classes, but they don't explain how to achieve it' (Q1 SC.9, 2020). Although this viewpoint could be interpreted as the teacher encouraging a learning-based method (Ochoa C. et al., 2015), it could also be understood as supporting the need, as introduced in Chapter 1 (p.10) and discussed in the Literature Review (pp.38-45) for sustainability content to be explicit in the curriculum.

The questions and a summary of the data collected from the students' responses to each question can be reviewed in the Appendix G1.3. Curriculum Inquiry Cycle 3 Results, p.361. This information was transcribed and translated from a video, recorded in the Gesell chamber.

4.6.2. The Focus Group with professors

The professors were asked to reflect on the following three questions:

Q1: Have you modified and / or introduced sustainable development curriculum content in your courses in the last three semesters? If the answer to this question is yes:

1.1. Can you describe what this focussed on and the main reasons for this focus?
1.2. In what subjects do you promote sustainable development learning?
1.3. In what contexts did the learning take place?

Q2: Can you give examples of academic projects through which you promoted sustainable development centred learning and teaching?

Q3: What do you think your students can apply in their practice now, that is different from how it was applied before the last three semesters?

3.1. What do you think this research can lead to?
3.2. Do you think it could make a difference to how students and teachers think about educational practice and the practice of design?

Q4: We are creating an online space to promote learning in the sustainable development of design. What would you like to find there?

The professors' reflections on the Curriculum Interventions indicate that the Project courses reinforced the subject of sustainability. For example, a professor described a project with an external organisation in which the students had to 'solve the three axes of sustainability. The professor observed:

> a change in the students now that the sustainable theme in the subjects of projects has been reinforced.
> (Q2. PA.1)

Aligned to the UNESCO definition of sustainable development (pp.10,11), this interviewee also considered that as a result of the interventions 'there is more awareness in the students, in the importance of designing, considering the following generations (Q1. PA.1).

The professors promoted the use of 'real' projects and discussed the relationship between assessment and projects. In this context, a professor believed that

> as far as possible, students should be encouraged to develop real projects, linked to real external agents, because that increases students' motivation and commitment.
> (Q2. PD.1).

In this context, another interviewee identified the importance of measurable criteria, designed for real projects (Q1. PA.2). The professor explained how the students design 'their own project indicators', based on 'matrices' designed for specific projects, and proposed that indicators should be measurable and specific to the 'real context' of a project (Q1. PA.2).

An interviewee, who specialises in economics, identified the need for training in relation to sustainable development in the context of design (Q1. PD.2). While training is addressed through the University's programme of continuing professional development, it is worth noting that a specific objective of the online learning space is to offer different SD teaching and learning resources for professors who are no experts but want to teach and promote SD in their project courses. This aspect is discussed in the next chapter 5.

The questions and a summary of the data collected from the professors' responses to each question can be reviewed in the Appendix G1.3. Curriculum Inquiry Cycle 3 Results, p.396.

4.6.3. The Focus Group with external guests

The third focus group invited external guests to consider the findings of the curriculum inquiry from their professional perspectives. As noted above, this group comprised the experts who had participated in the curriculum scoping, in Cycle 1.

The questions were used to prompt discussion on the extent to which and in what ways the interviewees considered sustainable development (SD) to be important in their current life and work and what had made a difference to their perceptions of SD.

The professors were asked to reflect on the following three questions:

Q1: Do you consider sustainable development in your current professional life and work? If your answer to this question is yes: 1.1. To what extent and in what ways is sustainable development important in your current life and work?

1.2. What has made a difference to how you perceive the importance of sustainable development in relation to your work?

Q2: Do you promote sustainable development in your company? 2.1. Can you give one or more examples of recent projects through which you and/or your company promoted sustainable development?

Q3: Do you consider sustainable development in your personal life? 3.1. To what extent and in what ways is sustainable development significant in your personal life and how does it relate, if it does relate, to your professional life and work?

3.2. What has made a difference to how you perceive sustainable development?

Q4: What do you think design and architecture students can apply in their practice now, that is different from what they could apply in the past? 4.1. What do you think this research can lead to?

4.2. Do you think it could make a difference to how students and teachers think about the practice of design?

Q5: We are creating an online space to promote learning in sustainable development in design and architecture education. What would you like to find there?

The majority of the external guests' responses to the above questions echoed and reinforced the main findings from the inquiry. In particular, the participants highlighted the important role of education in improving SD in Mexico, the need for fundamental change, the alignment of stakeholders in SD and the importance of a practical Design curriculum, where theory is applied to practice and the students work on 'real projects' (EG.1, 2020).

4.6.3.1. Universities and the alignment of stakeholders in sustainable development

An external guest asserted that the 'mentality', which causes the failure to address sustainability problems, until they start to 'affect us', must change [and that] 'this is why education is very important' (EG.2, 2020). This interviewee proposed that lessons learned from projects should be documented to inform future projects (EG.2, 2020). This practical idea supports an important finding from the inquiry; that in the context of sustainability, the curriculum requires a continuous process of development, adaptation and improvement, as it is applied in practice (p.18).

In the context of fundamental change, an external guest recommended that the 'concept of success must be re-defined' and specifically proposed that TEC should integrate 'social entrepreneurship, which is dedicated to trying to solve social problems' into the University's existing 'paradigm of being an entrepreneur' (EG3, 2020). Another external guest, who is supporting the government of Mexico in developing strategies and implementing sustainable development initiatives, contrasts 'the good intentions of the government' with

obstacles that 'prevent the implementation of necessary policies' (EG.5, 2020). This guest went on to suggest that 'there may be ways to push the government to go in the right direction' (EG.5, 2020).

An external guest highlighted the importance in education of 'theory applied to practice' in relation to the new Tec21 Educational Model, through which 'students work on real projects' (EG.1, 2020). This theme was discussed by another guest who asserted that it is 'necessary to question what development means' and in this respect, that '[w]hen students develop empathetic projects, they learn to see real needs, not only perceived ones, in order to propose a real solution' (EG.3, 2020).

4.6.4. Synthesis of the findings from the Focus Groups

Overall, the Focus Groups' responses reinforced the reliability and validity of the findings from the inquiry. In particular, the Focus groups agreed that the integration of SD into the new Design curriculum should involve all stakeholders in SD in generating curriculum content, learning and teaching methods and approaches and that this process should continue, as the subject of SD and the curriculum evolves.

- Sustainable development should no longer be an option in the curriculum (Q1.CI.7)
- The students who had participated in the Project courses recognised that they had increased their SD knowledge and engagement in solving sustainability problems (Q1.CI.7)
- The Project courses formally required the students to investigate sustainability to support their projects (Q1.CI.8)
- ESD curriculum design and practice requires the alignment of all aspects of a project (Q1.CI.9)

The External Guests emphasised the importance of real projects in the SD learning process:

- It is important to apply theory to practice and for students to work on real projects (Q4.EG.2)
- Project indicators should be measurable and specific to the 'real context' of a project (Q3.EG.1)
- Real projects can increase student motivation and commitment (Q4.EG.2)
- An effective ESD curriculum can counteract the state of affairs by which SD is complex and a contested concept by using 'real' projects in specific contexts. This enables student learning to engage in 'real needs, not only perceived ones' (Q4.EG.3)

The External Guests also proposed continuous curriculum development

- ESD requires a process of continuous research, adaptation and improvement. This can be supported by documenting projects to inform future projects. In this way, the students' investigations provide a resource for future projects, contributing incrementally to the development of SD content (Q1.EG.2)
- Convergent with data collected from the Interviews with Experts (Cycle1), the 'mentality', which causes the failure to address sustainability problems, until they start to 'affect us', has to change [and that] 'this is why education is very important' (Q1.EG.2)
- TEC should integrate social entrepreneurship into the University's paradigm of entrepreneurship (Q1.EG.3)
- The national standing of TEC should enable the outcomes of the inquiry to inform the development of the government of Mexico's education policy. (Q2.EG.5).

The next chapter (Chapter 5) is dedicated to the unplanned activities from the curriculum inquiry. The final chapter (Chapter 6) then brings together the important findings from the Curriculum Inquiry and the unplanned activities.

Chapter 5. The unplanned outcomes from the Curriculum Inquiry

As identified in Chapter 3 (p.84), a 'significant feature of action research [...] is that it operates in cycles' (McNiff et al., 2002, p.22). For McNiff et al., 'transforming action research cycles into spirals of action', enables the 'dynamic' of an inquiry to be communicated as it evolves. These actions can then lead to 'side spirals', as new areas of the inquiry emerge (McNiff et al., 2002, p.22). For these authors, this flexibility enables 'the complex and creative business of real life [to] be accommodated (McNiff et al., 2002, p.22).

This chapter presents the outcomes from the inquiry, which arose from the unplanned activities of the study. The first section (5.1.), focuses on the inquirer's communication actions and publications, informed by and undertaken during the inquiry. The second section (5.2.), outlines the development of Sostek, the online learning space. This initiative was stimulated and informed by findings from the review of the literature on social and collaborative innovation, the Curriculum Scoping and Curriculum Interventions. Specifically, the Curriculum Interventions identified the need to create flexible SD learning and teaching tools and resources, to support the participants in the inquiry.

5.1. Communication actions, including academic publications undertaken during the study

As highlighted in the Literature Review (p.33), a specific objective of this inquiry was to engage in and contribute perspectives, drawn from the study in Mexico, to international communications on design SD-ESD. The table below (Table 23) presents the communication actions and publications undertaken during the study.

Table 23. Communication actions and publications

Communication	Forum / Publication	Date
Evaluating the development of Sustainability competencies and knowledge in the Architecture and Design students	7th International Conference on Education 2021, Sri Lanka.	March, 2021
Promoviendo la educación para el desarrollo sostenible mediante recursos en línea (Poster)	International Conference of Educational Innovation, Tecnologico de Monterrey, Mexico.	December, 2020
Promoting Sustainable Development Education through Competency-based Education Supported by Online Resources	The 4th International Conference on Digital Technology in Education, Busan, South Korea.	September, 2020
Integrating Sustainable Development into the Curriculum - A case study on the developing of Sustainability competencies in Industrial Design students at a Undergraduate level in Mexico	International Higher Education Teaching and Learning Education, UK. https://doi.org/10.1108/S2055-364120200000018022. Title of the book: 'Integrating Sustainable Development into the Curriculum'	2019
Caso de estudio sobre la integración de competencias en desarrollo sostenible en el plan de estudios	International Conference of Educational Innovation, Tecnologico de Monterrey, Mexico. ISSN: 2594-0325.	December, 2019
Apoyando el Desarrollo sostenible de México a través de la exploración de enfoques innovadores en el plan de estudios de diseño industrial en la educación superior	International Conference of Educational Innovation, Tecnologico de Monterrey, Mexico. ISSN: 2594-0325.	December, 2018
Enfoques innovadores en la enseñanza de Diseño Industrial	Edubits, Tecnologico de Monterrey. https://observatorio.tec.mx/edu-bits-blog/enfoques-innovadores-ensenanza-diseno-industrial	May, 2018
Supporting Mexico's Sustainable Development Through Exploring Innovative Approaches to the Product Design Curriculum in Higher Education	Festival of Teaching, Birmingham City University. Poster Presentation	July, 2017

The table below presents the unplanned activities from the inquiry in relation to the TEC calendar and the cycles of the Curriculum Inquiry.

Table 24: Reconnaissance, Curriculum Inquiry / unplanned activities, Reconnaissance

TEC Calendar, Curriculum inquiry and unplanned activities			
TEC Calendar		**The Three Cycles of the Inquiry**	**Unplanned activities**
Fall Semester	Spring Semester		
August 2018 - December 2018	January 2019 - May 2019	Cycle 2 Curriculum Interventions / Student Course Surveys: Trial and Second Iteration (Product Design)	Chapter for a book International Higher Education
			International Conference, Educational Innovation, Tecnologico de Monterrey (TEC), Mexico
Start of the Tec21 Educational Model			
August 2019 - December 2019	February 2020 - June 2020	Cycle 2 Curriculum Intervention / Student Course Surveys: Third Iteration (Product Design and Architecture)	'The Urban Thinker', Columbia University, New York
			The Sostek online space, developed at TEC to support SD learning and teaching
	February 2020 - June 2020	Cycle 3 Focus Groups	Development of Sostek SD student project support
August 2020 - December 2020			International Conference, ICDTE 2020 South Korea

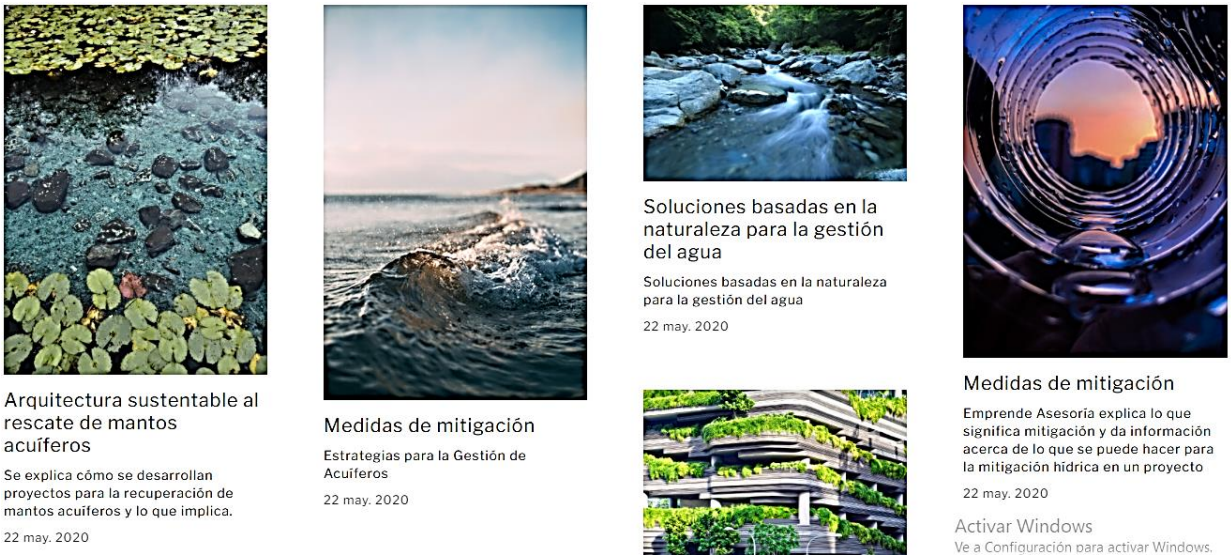
5.1.2. A chapter for an international publication on ESD

This section outlines one of the inquirer's main publications, which resulted from the inquiry, a chapter for an International Higher Education publication on ESD and the development of an online SD learning space. In 2018, the International Higher Education Teaching and Learning Education Association (HELT) called for chapter proposals for a book entitled 'Integrating Sustainable Development into the Curriculum'. This offered an opportunity for the inquirer to contribute to international communications on ESD, from the perspective of the research in Mexico. It also provided a chance to counterbalance the general tendency, as found through the Literature Review, for the literature on SD-ESD to originate from countries outside of Mexico (p.33). The chapter proposal outlined the integration of sustainable development into the Industrial Design undergraduate curriculum at TEC, with a focus on the formulation and testing of the SD competencies. The proposal was accepted and in 2020 the chapter was published in the section of the publication on the theme of a systemic approach to ESD. The chapter is entitled ‘Integrating Sustainable Development into the Curriculum - A case study on the development of Sustainability competencies in Industrial Design students at undergraduate level in Mexico’.

5.2. The online SD learning space

> Teachers can promote in their classes, that students enter the space to find useful resources for their projects and information on sustainable materials for their prototypes.
> (A student from the Focus Group, 2020)

Figure 4. Pages from the online space



The online space, named Sostek, went live in January 2020 and can be accessed at https://www.sostek.how/

As outlined in Chapter 2 (p.66), the creation of the online learning space was initially seen as a method of supporting the Curriculum Interventions. In particular, the idea behind the resource responded to the participating students and professors who found, through their experience of the interventions, that they required more information on SD curriculum materials to support their design projects. The interventions also identified the potential to develop a test that would enable the students to continuously evaluate their development of the SD competencies, designed for the interventions. In 2019, these findings, in conjunction with the review of the literature on social and collaborative innovation (p.65), formed the basis for a project proposal to TEC's 'NOVUS educational innovation' initiative. The inquirer, a professor in the University's Department of Sustainable and Civil Technologies, School of Engineering and Sciences and a professor in Architecture, collaborated to propose the creation an online learning space, to support ESD (the undergraduate Industrial Design

and Architecture programmes at TEC). The proposal was successful, and the funding enabled the inquirer to employ three students to collaborate and assist in the development of the online space. For example, the students assisted the research and development of digital resources for the space. The three students were from TEC's undergraduate degree in Sustainable Development Engineering, Digital Arts and Architecture. Additionally, five Industrial Design students, who were scholarship holders, helped to develop the online space. It is worth noting that the inquirer and one of the professors in the Sostek group are members of TEC's Undergraduate's Academic Aspects Team (EAAC), which is responsible for developing the University's curricula at a national level. This collaborative group, led by the inquirer, designed and guided the development of the online learning space. The initiative was designed as pedagogy for the new Design programme beyond the timeframe of the Curriculum Inquiry.

The name of the online space, Sostek, combines the word Sustainability (in Spanish is Sostenibilidad) and 'tek', which in Spanish, sounds the same as TEC.

5.2.1. The design and development of the online learning space: Sostek

Figure 5 below, presents the design of the online space. The space offers users two sections: a set of interactive ESD tools and a set of SD-ESD information resources.

Figure 5. The sections of Sostek

Sections of the Sostek	
Section #1	A set of interactive tools, including personalised SD competencies resources and a platform for communications. This section includes a tool designed to support the students in evaluating the sustainability of their projects.
Section #2	A resource containing SD learning and teaching materials. This includes power point presentations on different SD topics for professors who want to teach specific themes.

The two sections of Sostek were designed in response to findings from meetings between the inquirer and the professors toward preparing for the Curriculum Interventions, and between the inquirer the participating students and professors, during the undertaking the interventions.

The meetings with the professors found that the:

- teachers/professors, who may not be SD subject experts, would benefit from improved access to design SD/ESD resources to support their projects (the Project courses of the interventions)

The meetings with the participating students and professors, during the interventions, found that:

- additional learning resources would help the participants to address the SD requirements of their Project courses
- access to the resources should be flexible and enable their continuous use at any time and at any stage in a project.

It is worth noting that the italicised texts in the sections below, 5.2.1.1. and 5.2.2. are used to signal specific topics within the chapter's sections.

5.2.1.1. Section #1 of Sostek

The above two findings led to the design and development of two interactive SD tests.

1. SD competencies tests
2. SD project support tests

SD competencies tests
The SD competencies tests enable the students to evaluate their development of the SD competencies, at any point in their design project. Based on the students' responses to a series of questions, the tests provide personalised feedback, according to disciplines and levels of study, as follows:

- by discipline: one version of the tests is for Design students and the other is for Architecture students
- by level of study: the tests are designed for students in the first three semesters, second three semesters and third three semesters of their undergraduate programmes (Design and Architecture).

The Sostek competencies SD tests were used for the first time in the Spring semester of 2019 by all Design and Architecture students enrolled on a Project Course. After completing the tests, in addition to personalised feedback, the students receive digital resources, relevant to their feedback, to support the development of their projects and SD competencies. As noted earlier, the SD competencies were applied to the Curriculum Interventions in advance of TEC's introduction of the system of CBE, from August 2020, as a feature of the Tec21 Educational Model.

The second set of tests were piloted during the Curriculum Interventions in the Spring semester of 2021, in June. The students who participated in these tests were the same as those who had participated in the Curriculum interventions. The list of questions for the pilot test can be reviewed in Appendix H, (p.412) and the results of the tests that can be reviewed through the online learning space (http://sostek.how/herramientas).

These tests provide opportunities for the students and professors to identify

- aspects of SD that are not being considered by the students in their projects, and
- topics that are of most interest to students.

5.2.1.2. Section #2 of Sostek

Section #2 of the learning space provides resources, including ongoing SD-ESD communications, publications and opportunities to review SD learning and teaching materials. This includes digital presentations on different SD topics for professors who plan to teach specific themes.

5.2.2. The main findings from the Focus Groups in relation to the online learning space

As presented in Chapter 3 (p.92), three Focus Groups (students; professors and external guests) were invited to reflect on the main findings from the Curriculum Interventions and to offer their opinion and viewpoints on the online learning space. As presented in Chapter 4 (pp.159-161-163), one of the predetermined questions for the Focus Groups centred on the online learning space: the participants were asked to consider what they would like to find in

the space. This section presents the main findings from the three Focus Groups' responses to this question.

Information supporting student SD projects

Overall, the responses from the Focus Groups indicated that the online learning space provides an effective tool for promoting SD learning and teaching. The students identified the importance of finding information on materials for their design projects. For example, a student proposed 'a catalogue of materials with the prices and options for accessible prices' (P#1, 2020). Another student recommended a catalogue of materials, explaining that 'environmentally friendly materials are very expensive and difficult to obtain' (P#2, 2020). This student suggested that the University could 'look for agreements for this topic so that [students] have access to that information on the website that is being designed' (P#3, 2020). A student recommended that the space could provide 'information on what to do with the unused homework materials at TEC'; materials that cannot be re-used (P#4, 2020).

SD information for users, inside and outside universities

Reinforcing the need to increase SD knowledge in society (P#4, 2020):

- A student proposed that the space could provide information on 'collection centres'; for example, for materials such as 'Ecolana'. This student emphasised how the space could 'let people know where to take their batteries, bulbs, expired medicines'. (P #5, 2020)
- A student suggested that the learning space 'can reach people with basic concepts' (Q4. CI.7)
- A student recommended 'resources for people who do want to learn more deeply and commit' (Q4.CI.8)

The online learning space as a collaborative educational method

A student recommended collaboration between students and professors with interests in SD:

> to avoid isolated efforts: the impact will be greater when working as a team. Sometimes there are several people working on the same or a similar project without knowing. This would save time and effort by working together.
> (P#1, 2020)

This student also proposed investigating 'what else is already being done at TEC with respect to SD (Q4.CI.7.).

The online learning space: SD knowledge and developing SD mindsets

In the Focus Group with external guests, a participant proposed that the space can promote knowledge, 'empathy' and a change of mentality toward sustainability and recommended the inclusion of 'statistical data on the situation and on what may happen if we do not act now' (P#2, 2020). Reflecting this emphasis on knowledge and personal development, a student proposed that 'teachers should use the online space so that they are the first to change their mindsets toward sustainability' and that:

> teachers can promote in their classes that students enter the space to find useful resources for their projects and information on sustainable materials for their prototypes.
> (P#3, 2020)

A student suggested that the space could support the transferability of the online space to other disciplines at TEC.

Publications

> It is a good idea for the online space to have a bank of projects because it serves as a reference for the following generations of students. They can see what has worked, what has been addressed and how it was achieved.
> (P#2, 2020)

The three Focus Groups proposed that the online space acts as a resource for publications. A student suggested a 'directory of companies and emerging sustainability projects [as] ideas and proposals [are being] generated by young people, students at TEC, biotechnology students' (C1.7, 2020). An external guest proposed using the online space to 'publish success stories' (PA.2, 2020). This idea was echoed by a professor, who recommended that the space could publish student projects and that the selection of the projects could be based on 'how successfully sustainability had been developed through the project in relation to social, environmental and economic aspects' (P#2, 2020). This professor further recommended that this 'initiative would inform others in the School of SD projects and develop a bank of project data to share as a source of inspiration and ideas' for others (P#2, 2020).

Style and appearance

A student recommended that the online space should 'not be saturated with many texts' (Q4.SC.9). Another student suggested that the space should be 'dynamic' and include infographics and audiovisual materials (Q4.CI.7).

5.2.3. The main findings from the process of developing the online learning space

The process of developing tools and resources for Sostek enabled Architecture and Industrial Design students and professors to learn alongside each other (Blakey et al., 2015, cited in Krstikj, 2021, p.3). In this regard, the students and professors observed how their participation in developing the space generated a positive momentum, as the content and instruments of the space evolved.

The Focus Groups' responses provided evidence that:

- the students see the space as actively supporting their projects (p.160)
- the interactive section of the online space supports the integration of SD in the undergraduate Industrial Design (now Design) and Architecture curricula at TEC, by enabling the students to continuously evaluate their SD learning (p.173)

Aligned to the importance of SD learning encompassing knowledge content and personal development (p.134), the interactive section of the learning space provides users with personalised feedback. This function, which was developed by the Undergraduate's Academic Aspects Team (EAAC), provides Design and Architecture students and professors with a flexible SD pedagogy for future ESD curricula interventions. The interactive section of Sostek (Section #1) also acts as a design SD-ESD curricula resource for TEC and other universities. In this regard, Sostek provides:

- a bank of projects (P#2, 2020)
- a model for the development of equivalent SD learning spaces in other disciplines
- access to communications on SD-ESD, using the languages of Spanish and English

As an active collaborative educational method (Krstikj, 2021, p.1) Section #2 of Sostek:

- provides a flexible means of communication to support the development of collaborative networks, including multidisciplinary working groups (Expert E, 2017), across the University's campuses and other universities
- contributes to counterbalancing the deficiency of materials on SD in Spanish
- generates and promotes SD curricula content and pedagogy for the use of all students and educators at TEC, and other universities
- provides accessible and diverse materials on SD, complementary to the materials of formal classes and
- facilitates multidisciplinary learning and teaching, by involving participants with different levels SD knowledge and / or different discipline-related SD knowledge
- enables students to contextualise their SD learning through engaging in formal and informal learning environments (Lahmidi et al. 2019);
- contributes to communicating the research locally, nationally and globally

Sostek is a not-for-profit social innovation (Krstikj, 2021, p.4). As highlighted in Chapter 1, not all students at TEC are able to benefit from participating in activities such as summer schools and internships abroad (p.24). In this regard, Sostek:

- opens opportunities for all learners to benefit from access to local, national and global SD perspectives.

The Curriculum Scoping (p.27) and the Literature Review (p.101) combined to inform the model of SD-ESD: sustainable development and education for

sustainable development as interdependent and acting in mutually supportive ways (Haaz, 2017; UNESCO, 2012). As a collaborative educational method, Sostek:

- supports this model be providing opportunities for all citizens to engage in SD learning and actions
- offers a means for universities to act as a 'common arena' for all stakeholders in SD (Expert A, 2017)

5.2.4. Future development of the online learning space

The Focus Groups' responses to the online learning space demonstrate the potential for future research and development to improve and expand the tools and resources of the space. The NOVUS initiative at TEC, calls for proposals on an annual basis. A student in the Focus Group suggested that, as the model of the learning space can be transferred to other disciplines at TEC, a future NOVUS proposal could focus on extending Sostek to other disciplines at TEC.

As outlined above (p.176), in June 2020, a second SD online test was piloted. In addition to complementing the SD competencies tests and providing a curriculum learning and teaching tool for undergraduate Design and Architecture students and professors, this second test, which is now applied to the Architecture and Design curricula at the end of each semester, enables the collection of a broad range of data to support the continuous process of integrating SD into the curriculum. This test can be adapted according to the evolving nature of the students' projects, and in the same way as the SD competencies tests, it is available to all students, at TEC and any other University.

As outlined in the previous chapter (p.150), following the Curriculum Interventions, the inquirer presented the findings from the interventions,

together with an external guest (who had participated in the inquiry), to a nationwide professional development forum at TEC (CADi). As an outcome of this presentation:

- the professors at TEC expressed their intention to apply the Sostek platform to their courses, including the two Sostek tests. Six of the professors reported that they had already started to use Sostek
- a Design professor from another University in Mexico, reported that she intended to adopt the use of the Sostek and
- a professor from TEC, who also teaches at another university in Puebla (Mexico), reported that she had started to use of Sostek, including the tests, at TEC and at the other university

In April 2021, the inquirer provided a short course on ESD for The Architects Union of Puebla (CAPAC). As architects from six universities in Puebla attended this course, this opportunity enabled the inquirer to communicate the benefits of Sostek to a wider community of educators.

The inquirer considers that the Sostek tests can be adopted by other disciplines at TEC and that in this way, Sostek demonstrates the potential to contribute to answering the research question:

> 3: Given SD's 'process of change' (UNESCO (2017), how can SD and ESD be integrated into TEC´s processes of curriculum development?

Based on the above uses of and interest in adopting Sostek, and the experience of developing Sostek, the inquirer observed how this ESD initiative, which started with a more local and discipline focus, created a positive momentum beyond its original scope. Based on the evidence outlined above, the inquirer also believes that Sostek demonstrates the potential to continue develop after the timeframe of the inquiry, and in this way, to:

- encourage more SD-ESD projects and
- provide an effective means of communicating and acting beyond the university campus.

The inquirer proposes that this outcome from the inquiry exemplifies how action research operates in cycles, how planned cycles can lead to 'side spirals', and how their combination enables the 'dynamic' of an inquiry to be communicated as it evolves (McNiff et al., 2002). As highlighted in the Literature Review (p.33), a specific objective of this inquiry was to contribute perspectives, drawn from the inquiry in Mexico, to international communications on design SD-ESD. The next section summarises how the unplanned activities from the inquiry as a whole, contributed to answering the research questions.

5.3. The main findings from the unplanned activities from the inquiry

As outlined above (Table 23, p.170), the inquiry led to a series of communication actions, through which the inquirer was able to engage in and contribute to local, national and international discourses on design SD-ESD. In this way, the unplanned activities from the inquiry help to add to the literature on SD and ESD, from the national setting of the research in Mexico.

The inquirer considers that combination of the unplanned activities from the inquiry contribute to answering the research questions.

1. What are the most effective ways of ways of improving ESD in Mexico?
2. In what ways can an improved ESD Design curriculum contribute towards achieving the quality education goal of Mexico?
3. Given SD's 'process of change' (UNESCO, 2017), how can SD and ESD be integrated into TEC´s processes of curriculum development?

As outlined above, Sostek:

- contributes to the quality of SD education by providing tools and resources for Design and Architecture students and professors at TEC and other universities in Mexico and globally
- demonstrates the capacity to extend ESD curriculum development to all TEC campuses

Since the commencement, in September 2019, of the new Design programme, Sostek has been fully integrated into the curriculum, Therefore, this initiative contributes, as a continuing pedagogy, to answering the research question:

> In what ways can curriculum change, with the objective of integrating sustainable development into the Industrial Design curriculum, contribute towards achieving the 'quality education goal' of Mexico (PND 2013)?

Chapter 6. Conclusions to the Curriculum inquiry

This chapter restates the research objectives and the research question before discussing (or explaining) the ways in which the outcomes from the inquiry contributed to achieving the research objectives and answering research question. This leads into outlining how the study contributes to knowledge in the field of Design ESD and considerations of the limitations of the inquiry, arising from its scope and methodology. The chapter concludes by proposing areas for future research in this field.

6.1. Achieving of the research objectives

The overall objectives of the research were to integrate SD into TEC's Industrial Design curriculum (research objective 1) and into the university's educational initiatives, enabling the continuous development of the curriculum (research objective 2).

The research question helped to narrow the focus of these objectives.

During the early period of the study, the inquirer recognised the importance of exploring a range of learning and teaching content methods and approaches towards reorienting the Industrial Design curriculum at TEC. Therefore, the original research question (p.30) focused on 'learning objectives and learning contents', as stated in the government of Mexico's PND (2013).

> In what ways can innovations in design education, for sustainable development, contribute to developing 'relevant learning objectives and learning contents' towards achieving 'the quality education goal' of Mexico (PND 2013).

The review of the literature on design, SD and ESD discourses resulted in a more open approach to exploring how the literature could inform the inquiry. For example, the review helped the inquirer to understand that the original research question specified the importance of *innovations* in Design ESD before developing a deeper understanding of the ways in which the literature reviewed on educational theory could influence the inquiry and help to focus the research objectives. The second iteration of the question (p.76) integrated research objective 1 and replaced *innovations* with *curriculum change*.

> In what ways can curriculum change, with the objective of integrating sustainable development into the Industrial Design curriculum, contribute towards achieving the 'quality education goal' of Mexico (PND 2013)?

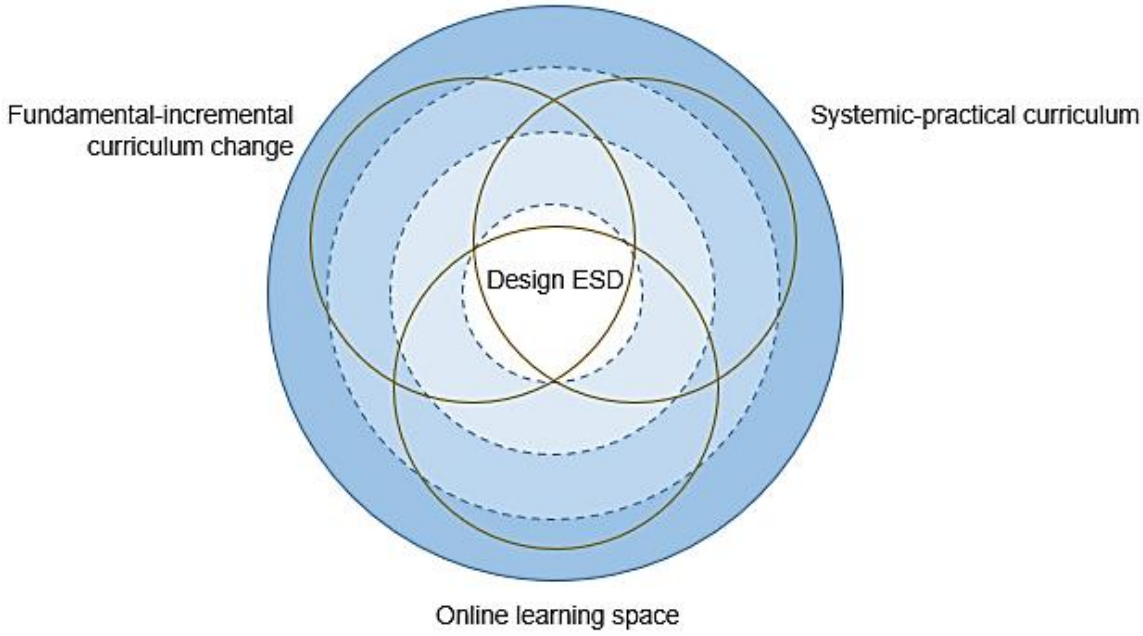
The specific research objectives also gave emphasis to exploring *how* to improve education for sustainable development in Industrial Design, in Mexico. The specific research objectives are restated below, in section 6.2., as they relate to discussions on the conclusions to the inquiry.

The outcomes of the inquiry achieved the overall research objectives in the following ways.

6.1.1. The integration of SD into the new Design curriculum, across TEC

Through membership of TEC's Academic Aspects Undergraduate Team, informal working groups and collaboration with external experts, the inquirer contributed to the renewal of the university's new curricula, at a national level (p.21). This contribution resulted in TEC implementing the new Design ESD curriculum framework and SD competencies, as formulated through the study, across the university's undergraduate Design and Architecture programmes at the Puebla campus.

Figure 4. Design ESD curriculum framework



6.1.2. Continuous ESD curriculum research and development

The findings from Cycle 1 emphasised the importance of universities increasing their research and development efforts and generating research projects for social impact (p.118). Similarly, in the context of ESD curricula development, the Literature Review found that because of the complex and evolving nature of design and SD, before integrating SD into the curriculum, the scope and realities of the subject should be explored (p148). The inquiry also found that, because of the evolving nature of design and SD, an effective Design ESD curriculum should involve a continuous process of research and development (p.165).

The outcomes of the Student Course Surveys in Cycle 2 provided evidence that the inclusion of SD content and assessment criteria resulted in the participating students recognising advances in their SD learning. The survey results showed that the first (Trial) intervention had the greatest impact on the students' SD learning. The inquirer considers that this was because the Trial intervention was the first time that the students had experienced the explicit inclusion of SD content and assessment criteria in the curriculum. Although more gradual, the second and third interventions continued to result in the students' recognising advances in their SD learning. This finding contributed to developing an understanding of how fundamental curriculum change should include incremental development: to build upon and sustain fundamental change.

6.1.3. Knowledge of SD in society

The Literature Review (pp.64-75) discussed the need for universities in Mexico to support the country's 'sustainable economic and social progress' (Government of Mexico's PND, p.15) and all universities to reorient their curricula to achieve 'new skills, values and attitudes that lead to more sustainable societies' (UNESCO, 2017, p.1). The Literature Review also informed the related specific findings that:

- SD and ESD should be mutually supportive and interdependent (UNESCO, 2012; Haaz, 2017)
- the deficiency of SD knowledge in society (p.118) is a significant barrier to improving SD in Mexico and therefore that:
- the new Design curriculum should act inside and outside universities.

The inquiry responded to the above educational agendas and findings by developing a systemic-practical curriculum and creating Sostek. The gap in information resources for the Curriculum Interventions and wider Spanish

speaking communities, together with the implementation of CBE for the first time at TEC, led to the development of Sostek. This collaborative pedagogy contributes to filling the identified research gap. That is, it supports the new Design curriculum, informing and inspiring SD actions in Design and Architecture, other disciplines at TEC, other universities and in communities.

6.1.4. The formulation and implementation of SD competencies

The inquiry informed the formulation and implementation of specific SD competencies, through which the participating students and professors in the Curriculum Interventions were able to measure the effectiveness SD learning, for the first time at TEC.

The results of the Student Course Surveys demonstrated that the implementation of SD competencies contributed in an important way to integrating SD learning methods and approaches into the curriculum (research objective 1) and into TEC's educational initiatives, enabling the continuous development of the curriculum (research objective 2).

The results also provided evidence that the interventions contributed to achieving specific research objective 3:

> to support the development and implementation of Competency-Based Education: enabling students to develop the competencies needed to make informed and responsible decisions.

The implementation of competencies in the interventions also supported the development of Competency-Based Education (CBE) at TEC, in preparation for the university's formal introduction of CBE.

6.1.5. External student projects

The findings from the inquiry, which support the argument that SD and ESD should be approached as interdependent concepts, contributed to informing the increase in external student projects, as a formal learning and teaching method, across TEC's new curricula. That is, they influenced the formal inclusion of external projects in TEC's new curricula. As described in Chapter 4 (p.127), the Tec21 Educational Model includes external projects as a requirement of all the university's undergraduate (Bachelor's) curricula. The University's previous curricula involved external projects but only on an informal basis. TEC's new curricula comprises two types of courses, 'block' and 'normal' courses, each amounting to around 50% of the curriculum. The 'block' courses formally require the inclusion of external projects. Therefore, when measured as a formal requirement, compared to the university's previous curriculum, this initiative represents an increase in the use of external projects of around 50%.

6.1.6. Connecting the Industrial Design curriculum to global perspectives on design and SD

Two of the three specific objectives of the inquiry centred on creating innovative learning and teaching methods and engaging in international communications on Design ESD.

1. create innovative learning and teaching methods and develop an understanding of how they can contribute to integrating SD into the Industrial Design curriculum at TEC.
2. engage in and contribute to international communications on design education for sustainable development, based on perspectives drawn from the setting of the inquiry in Higher Education in Mexico.

As the inquiry developed, these objectives were increasingly connected to one of the inquirer's original motivations to undertake the study. These motivations were to:

- connect the Industrial Design curriculum at TEC to global discourses on education for sustainable development (p.25) and in this way to
- broaden the students' knowledge of different international design contexts and perspectives (pp.26-27).

Chapter 5 presented the creation and development of the SD online learning space (Sostek). Sostek, which is now integral to the new Design curriculum, enabled the inquiry to develop an understanding of how innovations in learning and teaching can contribute to integrating SD into the curriculum at TEC (specific objective 1).

Sostek provides opportunities for students and professors at TEC to:

- contribute to international communications, based on their own experiences and perspectives (specific objective 1), generating design SD knowledge and
- to learn from others and this way, to increase and broaden their knowledge of SD in a range of situations and international contexts

As highlighted in Chapter 1 (p.26.), as a member of the Royal Society of Arts (RSA), during the study, the inquirer promoted the participation of TEC students in the RSA Student Design Awards and three TEC students won awards in the 2017 competition. The inclusion of this student competition in the curriculum provided a motivating learning method for the students and increased their connections to global discourses on SD and opportunities to contribute to solving local/global design problems.

The application of Sostek and international student competitions in the new Design curriculum supports the students' development of Competency #1:

> The student´s work demonstrates knowledge and understanding of SD locally/globally.

6.1.7. Multidisciplinary learning and teaching

The first year of the university's undergraduate curriculum includes courses, involving multidisciplinary learning and teaching. As identified in Chapter 4 (p128), these courses enable the students to broaden their knowledge of different university disciplines before specialising in their chosen discipline.

In April 2021, the inquirer was invited to contribute to a university working group, comprising six professors from different TEC campuses. The purpose of this group was to design a Year 3 specialisation module, named Regenerative Design, as part of the university's new curricula. This module, which will commence from the start of the 2022 Spring semester, involves professors in leading multidisciplinary projects in Year 3 of the curriculum and will be open to undergraduate students in TEC's Design, Architecture and Urbanism programmes. The professors who will teach the module will be from a range of disciplines, including Architecture, Industrial Design, Urbanism, Sustainable Development, Construction Management and Ethnography.

This element of the new Design curriculum will contribute to achieving:

> Specific research objective 1: to create and develop an understanding of how innovative learning and teaching methods can contribute to integrating SD into the Industrial Design curriculum at TEC.

> Specific research objective 3: to support the development and implementation of Competency-Based Education: enabling students to develop the competencies needed to make informed and responsible decisions.

The Regenerative Design module is expected to support the students' development of Competency # 5:

> The student looks for and finds knowledge inputs and expertise from other disciplines in order to meet the sustainability requirements that her/his project needs.

6.1.8. The integration of innovative learning and teaching methods into the curriculum

> Specific research objective 1: to create and develop an understanding of how innovative learning and teaching methods can contribute to integrating SD into the Industrial Design curriculum at TEC.

Chapter 1 introduced how the creation of Sostek addressed the need to fill a critical gap in the research: the lack of information on sustainable development for the students and professors participating in Curriculum Interventions (p.32). The Literature Review discussed the interconnections between the use of competencies, experiential learning, action research and Design ESD (p.58). Chapter 5 described the development of the online learning space: how it

gained momentum, generated new possibilities and inspired a greater ambition for the research. The inquirer proposes that Sostek provides evidence of the integration into the curriculum of an innovative pedagogy, which:

- enables students and professors to learn alongside each other
- facilitates multidisciplinary projects by providing SD information resources for students and professors with different levels and / or specific areas of SD knowledge
- supports the implementation of Competency-Based Education by enabling students to develop the competencies needed to make informed and responsible decisions (Specific research objective 3)

6.1.9. The research design supporting curriculum change

> Overall research objective: 2: to contribute to integrating sustainable development into Tecnologico de Monterrey's educational initiatives, enabling the continuous development of the curriculum.

Chapter 2 discussed the advantages of practitioner-led action inquiry in the context of curriculum research and proposed that fundamental change must be supported by incremental development (pp.58-74). Specifically, the interventions encouraged experiential learning. For example, the participating professors in the interventions adjusted their projects to include SD content and assessment criteria, and Sostek inspired collaboration and generated possibilities beyond its original purpose of creating a local (TEC) online SD learning space.

6.2. Contributions to knowledge

The inquiry was undertaken at TEC, a university with 36 campuses located across the five zones of Mexico. Therefore, the potential exists for the outcomes from the study to inform future ESD curriculum initiatives at TEC, other universities in Mexico and to influence the Government of Mexico's educational objectives, as part of the next five-year national development plan (PND). At the level of universities, through meetings with professors in other departments at TEC and in other universities in Mexico, the inquirer found that the methods undertaken in this discipline-specific study could be transferred to other disciplines.

The decision to focus this practitioner-led action inquiry on Design in Higher Education in Mexico, was founded on the inquirer's own practice as a professor in the disciplines of Design and Architecture. The specific focus on Design was considered in relation to the limits of the timeframe of the research. However, it is worth noting that the differences found between the integration of SD in the Design and Architecture curricula at TEC (p.145), contributed to the urgency of the focus on improving Design ESD. For professional reasons Architecture requires that SD is embedded in the curriculum. Therefore, collaboration with Architecture enabled the inquiry to learn from the more advanced ESD practices of the Architecture curriculum.

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The study inspired the creation of Sostek. The initial purpose of this initiative was to fill the gap in SD information resources for the students and professors participating in the interventions. As described above (p.195) and in Chapter 2 (p.85) the possibilities and ambition for Sostek increased as broader possibilities and new opportunities emerged during the study, including as mentioned in Chapter 5 (p.182), the adoption of the model by other universities, professional organisations and Spanish speaking communities.

Table 23 (p.170) presented the communication and publications actions undertaken during the research. Combined with Sostek, the inquirer proposes that these provide a foundation for future efforts to address the existing gap in sustainable design / ESD resources, from the perspectives of Mexico and other developing countries, for Spanish speaking communities. Supported by TEC's writing lab, the inquirer plans to translate sections of this thesis into Spanish to support the development of Design / ESD themes for Sostek. Previously, the plan had been to translate the whole thesis into Spanish. The inquirer considers that the focus on themes for Sostek should contribute more actively and collaboratively towards innovating learning and teaching methods for the new Industrial Design curriculum at TEC (specific objective 1).

6.3. The limitations of the inquiry

Chapter 4 explained that the Curriculum Interventions were applied to the Project courses of the Industrial Design programme, as these are the courses where the students integrate and apply the knowledge acquired during the rest of the courses (p.130). The Project courses amount to around 20% of the programme. The inquirer considers that the size of the sample group of students and the proportion of the Industrial Design programme, which the interventions was applied to, were appropriate to the objectives of the inquiry. However, a case study conducted over a longer period would have allowed the collection of data on the implementation of the SD competencies over the four years of the programme. This was beyond the timeframe of this inquiry. The inquirer considers that a more longitudinal study, comprising more than one research degree could be undertaken to investigate the ability of SD interventions in the curriculum to result in continuous incremental advances in SD learning, as this study evidenced.

6.4. Recommendations for future research in the field of ESD

The researcher considers that critical findings from the study demonstrate the potential for future research. This final section of the thesis identifies three interrelated recommendations. These relate to how the research filled the research gap in SD information resources for the interventions, as described in Chapter 2 and to investigating the social innovation dimension of SD (Krstikj, 2021; Iniguez, 2016; Stebbing, 2015, p.10).

6.4.1. The integration of social innovation into TEC's education and research

The inquiry indicates the potential for professors in the School of Architecture, Art and Design at TEC to collaborate in investigating the social innovation dimension of SD. This finding was informed by a meeting between the inquirer and Krstikj, a professor In Architecture at TEC, who as outlined in Chapter 2 (pp.65-66), had undertaken a social innovation research project (in 2021) with students at TEC. As the meeting took place in 2021, there was insufficient time to include a full enough investigation into how social innovation could inform future Design ESD research at TEC, as part of this study. Therefore, the inquirer recommends that the potential exists for TEC to consider the formal integration of this dimension of SD into the university's undergraduate curricula. In this regard, the social innovation and service-learning aspects of Sostek contribute to providing an example of a pedagogy, which encourages experiential learning (for students, professors and citizens). Therefore, a further recommendation is that Sostek offers a model, which allows the curriculum to actively affect change inside and outside the university.

6.4.2. Encompassing social entrepreneurship within TEC's professional paradigm

The inquiry found that the need for ESD to contribute to increasing SD knowledge in society increased in importance as the study developed. Therefore, in relation to exploring how social innovation could contribute to improving Design ESD, the inquirer proposes that the findings from the inquiry indicate that TEC's professional and entrepreneurship paradigm should encompass social entrepreneurship, as described in Chapter 4 (p.165).

6.4.3. The online learning space (Sostek) as a Design and Architecture curricula resource

The study found that the creation of Sostek:

- inspired collaboration between students and professors in promoting and supporting SD learning and teaching and
- motivated the students to participate actively in developing ways of supporting their personal development and future professional interests.

Sostek, responded to filling a research gap found during the interventions. Therefore, it was not available as a planned research method from the start of the inquiry. Based on the ways in which this pedagogy enabled the collection of more complete data, including fuller and richer data on the participants' personal responses and commitments to curriculum change and a progressive approach to curriculum change, the inquirer recommends that future ESD researchers consider the development of an online learning space from the start, or during the early period of the research.

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Appendices

Appendix A. The Tecnologico de Monterrey Industrial Design Curriculum

The tables below present the two previous Industrial Design curriculum versions at Tecnologico de Monterrey, the 2011 curriculum and the 2017 curriculum. The interventions were carried out in both of these programs. Note: the courses followed by an Asterisk (*) are the courses where the interventions were carried out.

Tecnologico de Monterrey, Industrial Design Curriculum, 2011	
Academic Year 1	
Fall	Spring
Semester 1	Semester 2
Drawing	Applied Geometry
Descriptive Geometry	Artistic Drawing
Design Fundamentals I	Design Fundamentals II
Models and Scale Models	Creativity and Innovation
Introduction to Design	Model and Prototypes Workshop I
Foreign Language	Analysis and Verbal Expression
Mathematics for Design	

Academic Year 2	
Fall	Spring
Semester 3	Semester 4
Product Design	Digital Modelling
Design Ergonomics	Audio-visual Language and Narrative
Design and Ethnography Methods	Product and service design
Natural Sciences and Sustainable Development	Ethics, Self and Society
Design Physics	Verbal Expression in the Workplace
Computer Drawing	Manufacturing Processes

Academic Year 3	
Fall	Spring
Semester 5	Semester 6
User-centered Design	Experience Design II *
Experience Design I *	Language and Meaning of Objects
Advanced Digital Modeling	Advanced Digital Representation Techniques
Model and Prototype Workshop II	Citizenship
Mexican Identity and Culture	Computer-aided Prototyping
Materials Technology	Topics I

Academic Year 4	
Fall	Spring
Semester 7	Semester 8
Futurology in Industrial Design	Planning, Innovation and Strategic Sustainability
Product and System Design I *	Product and System Design II *
Entrepreneurship	Innovation, Design and Business Setting
Manufacturing Models	Project Evaluation and Management
Topics II	Topics IV
Topics III	Topics V

Academic Year 5	
Fall	
Semester 9	
Business Strategic Foresight	
Innovation in Business Models and Family Business Management	
Professional Insertion Project *	
Introduction to Professional Development	
Applied Ethics	
Global Brands and Product Development	
Topics VI	

The Tecnologico de Monterrey Industrial Design Curriculum in 2017	
Academic Year 1	
Fall	Spring
Semester 1	Semester 2
Descriptive Geometry	Design Fundamentals II
Drawing I	Creativity and Innovation
Design Fundamentals I	Drawing II
Introduction to the Design Area	Mathematics and Physics for Design
Exploration Elective A-I, A-II and A-III	Exploration Elective B-I and B-II

Academic Year 2	
Fall	Spring
Semester 3	Semester 4
Applied Geometry	Digital Modelling
Model and Prototypes Workshop I	Design Ergonomics
Design Project I *	Design Project II *
Drawing III	Model and Prototype Workshop II
Foreign Language	Mexican Identity and Culture
Computer Drawing	Analysis and Verbal Expression

Academic Year 3	
Fall	Spring
Semester 5	Semester 6
Design Project III *	Design Project IV *
User-centered Design	Advanced Digital Modeling
Advanced Digital Representation Techniques	Futurology in Industrial Design
Ethics, Self and Society	Entrepreneurship
Verbal Expression in the Workplace	Citizenship
Materials Transformation and Selection I	Transformation and Selection of Materials II

Academic Year 4	
Fall	Spring
Semester 7	Semester 8
Professional Elective I	Complementary Professional Elective I
Professional Elective II	Complementary Professional Elective II
Professional Elective III	Complementary Professional Elective III
Professional Elective IV	Complementary Professional Elective IV
Professional Elective V	Complementary Professional Elective V
Professional Elective VI	Complementary Professional Elective VI

Academic Year 5	
Fall	
Semester 9	
Professional Insertion Project *	
Introduction to Professional Development	
Applied Ethics	
Elective I	
Elective II	
Elective III	
Elective IV	

Appendix B. Interviews with Experts, Questions (Cycle 1)

The interviews with Experts as part of Cycle 1, helped to establish a groundwork of information through the opinions and perspectives of the interviewed experts on the key drivers for SD, factors that are blocking SD and ways in which the education sector can contribute. The next table presents the six questions that were the basis of these interviews.

#	Question
1	What are the key drivers and facilitators for sustainable development (and why is such development of importance)?
2	What, if any, are the factors that are blocking or retarding sustainable development?
3	What might be done to diminish or eradicate such blockages?
4	In what ways might the education sector (and more specifically, the Higher Education sector) contribute to the promotion/achievement of sustainable development?
5	What are the current ‘big issues’ or open questions in relation to sustainable development?
6	If you have been involved in sustainability-oriented innovations, how were these designed, how did they perform, what made them successful (or not), and what was learned from the process?

Appendix C. The Nationwide Questionnaire format (Cycle 1)

Please respond to this **questionnaire** with openness and sincerity. Your opinions are very important and valuable for this research.

Section I. Demographics	
1	Gender
2	Age
	18-24 years old
	25-34 years old
	35-44 years old
	45-54 years old
	55-64 years old
	65-74 years old
	75 years or older
3	Name of the University
4	Position at the University

Section II. Inclusion of Sustainable Development in the curricula	
5	Number of topics related to the concept of sustainable development in the Product Design curricula
6	Time devoted to the issue of sustainable development in the Product Design curricula.
7	Time devoted to the issue of sustainable development in the classes you teach.
8	Do you consider that the sustainable development concept is embedded enough in the curricula? Why?
9	Do you consider that this topic is embedded in the practice and not only theoretically? Why?
10	Do you consider that this topic is reviewed with the necessary depth? Why?
11	How is the University measuring sustainability?
12	Is it having a real impact on students? Can you give an example?
13	Is the Product Design undergraduate promoting projects that consider the circular economy?

Section III. The Educational Environment	
14	Does your University promote teaching activities outside of the campus? Can you give some examples? (Learning beyond the traditional campus)
15	Does your University promote inter-University projects? Can you give an example?
16	Does your University promote multidisciplinary projects? Can you give an example?
17	Does your University promote focused social service? Can you give an example?
18	Is your University creating links to companies that are successful in sustainability issues?
19	Is your University promoting citizen participation on sustainability issues?
20	Is your University promoting student participation in social projects for communities in need?
21	Do you think that technology can be an efficient way to promote sustainability teaching?

Section IV. The curricula	
22	How often does your University change the curricula?
23	What factor(s) guide(s) the modification of the curricula in your University? (A personal agenda, a political agenda, industry, other_____

Appendix D. List of questions included in methods applied at TEC

The next list of questions was part of the methods applied at TEC in the Puebla, Toluca, Monterrey and Guadalajara campuses.

Questions for Tecnologico de Monterrey Academic Directors Design and Architecture Departments)	
Q1	What, for you, constitutes sustainable development?
Q2	Can you give an outline of the projects or activities related to sustainable development that are taking place in your region at Tecnologico de Monterrey?
Q3	In your opinion, what are the benefits of these activities and experiences for the students?
Q4	Are the benefits being measured? (e.g. student performance, graduate employment or further study)
Q5	Can you name other professors who are participating in these initiatives?
Q6	Can you give an outline of the projects or activities related to sustainable development that are taking place in multidisciplinary environments in the North region of Tecnologico de Monterrey?
Q7	Do you consider that the multidisciplinary experiences that are related to sustainable development and currently promoted in the Industrial Design program at Tec are sufficient?

Questions for Tecnologico de Monterrey Design students in in the Puebla, Toluca, Monterrey and Guadalajara campuses	
Q1	What, for you, constitutes sustainable development?
Q2	Can you give an outline of the projects or activities related to sustainable development that you have undertook during your studies at Tecnologico de Monterrey?
Q3	What benefits do you see in these activities and experiences?
Q4	Do you consider that the topics, activities and projects related to sustainable development are sufficient?
Q5	Can you give an outline of the projects or activities related to sustainable development that you have undertaken in multidisciplinary environments?
Q6	What benefits do you see in these experiences?
Q7	Do you consider that the multidisciplinary experiences that are related to sustainable development and currently promoted in the Product Design program at Tec are sufficient?

Questions for Tecnologico de Monterrey Design graduates	
Q1	What, for you, constitutes sustainable development?
Q2	Can you give an outline of the projects or activities related to sustainable development that you undertook during your studies at Tecnologico de Monterrey?
Q3	What benefits do you see in these activities and experiences?
Q4	Do you consider that the topics, activities and projects related to sustainable development were sufficient?
Q5	Can you give an outline of the projects or activities related to sustainable development that you undertook in multidisciplinary environments?
Q6	What benefits do you see in these experiences?
Q7	Do you consider that the multidisciplinary experiences that are related to sustainable development and currently promoted in the Product Design program at Tec are sufficient?

Questions for current Design professors of Tecnologico de Monterrey	
Q1	What, for you, constitutes sustainable development?
Q2	Can you give an outline of the projects or activities related to sustainable development that you have led in your classes at Tecnologico de Monterrey?
Q3	In your opinion, what are the benefits of these activities and experiences for the students?
Q4	Are the benefits being measured? (e.g. student performance, graduate employment or further study)
Q5	Can you name other professors who are participating in these initiatives?
Q6	Do you undertake sustainable development related projects or activities in multidisciplinary environments in your classes?
Q7	Do you consider that the multidisciplinary experiences that are related to sustainable development and currently promoted in the Product Design program at Tec are sufficient?

Appendix E. The Walking Interviews information format (Cycle 1)

This participatory and observational method of interviews belongs to ‘cultural mapping’; a systematic method of collecting information on ‘people’s historical and contemporary relationships with local environments’ and collecting ‘social, historical and ecological data in situ’ (Strang, 2010).

The inquirer photographically recorded different interior and exterior aspects of Tecnologico de Monterrey’s Puebla, Toluca, Guadalajara and Monterrey campuses. The following tables present a representative range of examples of the application. These include 6 main photographs of each campus.

The layout of the information below, follows the way the method was applied by the inquirer. The photograph is annotated in a factual way. This is followed by an interpretation of the image by what the image means or infers, in the context of education for sustainable development.

The inquirer used the following questions in relation to the interpretations: What does the photograph communicate about the curriculum? What does the photograph communicate about sustainable development education? What does the photograph communicate that the interview to the participants was unable to suggest?

The following tables present the format used for the Walking interviews with an example from the Puebla campus of Tec.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Puebla Campus.

The inquirer's photograph (05.02.2018), report and interpretation

Subject	Annotation
	This structure is a prototype habitable emergency module for people affected by earthquakes (date and location of the earthquakes). It was designed and constructed by students of the "semana i" project. The teacher who leads this project has not found the opportunity to donate this yet. it is still on the campus.

Interpretation

The image communicates a specific and practical way in which sustainable development, relevant to Mexico, is part of the curriculum, and that the designer of the curriculum has worried about creating solutions for people in need who were affected by the earthquakes.

Appendix F. The Competency-Based Education survey format

ID Number: _____, Semester: _____, Gender: _____, Age: _____, Date: _____
Subject:

Important note: Your names and personal data will be safeguarded and will be used only for research purposes. The conversations will be handled anonymously. If any of you had an objection, you can indicate it and decide not participate. Answering this survey does not positively or negatively affect your notes in this course.

1.- How much did you like the projects carried out in the Design Project subject this semester?

LOW 1 2 3 4 5 HIGH

2.- How much did you like the projects carried out in the Design Project subject the previous semester?

LOW 1 2 3 4 5 HIGH

3.- How much did you develop the following competencies this year? Evaluate from 1 to 5.

I. Your work demonstrates knowledge and understanding of sustainable development issues locally/globally.

January-May 2018	**August-December 2018**
LOW 1 2 3 4 5 HIGH	LOW 1 2 3 4 5 HIGH

II. Your work demonstrates a mind-set change in relation to sustainable development through the successful application of the principles to your projects as well as in your own lifestyle.

January-May 2018	**August-December 2018**
LOW 1 2 3 4 5 HIGH	LOW 1 2 3 4 5 HIGH

III. You are able to assess the life cycle of the product/s of your projects based on criteria that relate to the minimization of the multiple environmental impacts throughout the cycle.

January-May 2018	**August-December 2018**
LOW 1 2 3 4 5 HIGH	LOW 1 2 3 4 5 HIGH

IV. You encourage the rest of the group´s involvement in sustainable development when presenting your projects to the group,

January-May 2018	**August-December 2018**
LOW 1 2 3 4 5 HIGH	LOW 1 2 3 4 5 HIGH

V. You look for and find knowledge inputs and expertise from other disciplines in order to meet the sustainability requirements that your project needs.

January-May 2018	**August-December 2018**
LOW 1 2 3 4 5 HIGH	LOW 1 2 3 4 5 HIGH

Appendix G. Results of Cycle 1 of the Curriculum Inquiry

G1. Curriculum Inquiry Results

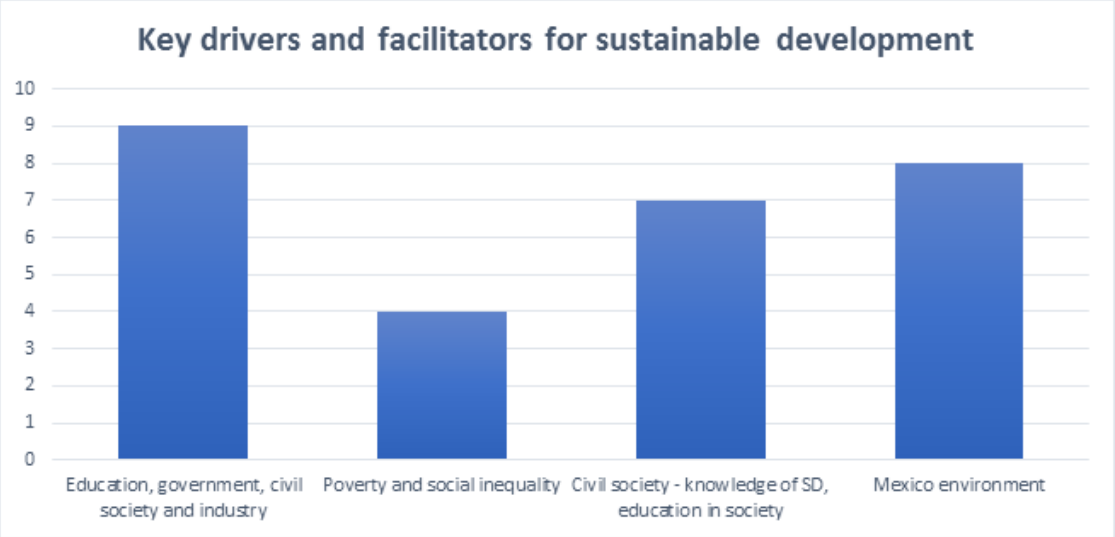
This appendix is organised in three sections:

- G1.1. Curriculum Inquiry Cycle 1 Results
  - G1.1.1. Results of the Interviews with experts.
  - G1.1.2. Results of the Community of Practice seminar
  - G1.1.3. Results of the Nationwide Questionnaire
  - G1.1.4. Results of the methods applied at TEC (1st).
  - G1.1.5. Results of the methods applied at TEC (2nd).
  - G1.1.6. Results of the Walking Interviews.
- G1.2. Curriculum Inquiry Cycle 2 Results
  - G1.2.1. Results of the trial curriculum intervention
  - G1.2.2. Results of the first curriculum intervention
  - G1.2.3. Results of the second curriculum intervention
- G1.3. Curriculum Inquiry Cycle 3 Results
  - G1.3.1. Results of the focus group with students
  - G1.3.2. Results of the focus group with professors
  - G1.3.3. Results of the focus group with external guests

G1.1. Curriculum Inquiry Results

G1.1.1. Results of the Interviews with experts

Question number 1: Key drivers and facilitators for sustainable development in Mexico



Education, government, civil society and industry

The experts' answers to this question provide evidence of a general consensus of opinion; that the stakeholders in sustainable development in Mexico, identified (by the majority of experts) as education, government, civil society and industry, must be aligned in order to achieve the country's SD objectives. A definition of stakeholders in the context of this work can be reviewed on page 19. Expert A, who has academic leadership experience in Mexico, proposes a 'quadruple propeller', by which 'if any of the stakeholders are not aligned, sustainable development cannot be achieved'. Within this model, society must demand that government initiatives are implemented, and universities must play their role as a common arena for the subject of sustainable development, in order to achieve a common agreement between the different parties.

In this context, Expert G, who has extensive programme leadership experience in Architecture and Design, in Mexico, focuses on the relationship between civil association and universities:

> Civil association + University = valuable and lasting results.

In the context of the topic of the inquiry, the use of the term ‘civil association’ by Expert G, is understood by the inquirer as ‘civic engagement’, defined as ‘individual and collective actions designed to identify and address issues of public concern’ (American Psycological Association, 2009).

Expert H, who directs a student design awards competition, set by an arts organisation in the UK with a global network, highlights how SD involves a broad range of ‘tangible environmental, social and economic factors’. In accordance with the above model of alignment (Expert A), and the role of universities (Experts A and G), Expert H affirms that SD ‘is about how these pieces fit together’ and that education plays an ‘extremely important role in driving SD forward’.

Similarly, Expert C, who is the co-founder of a social design association in Mexico, considers that Higher Education can be a significant SD driver, but ‘without the will of government, it is difficult to reach a development – [in Mexico], where we have isolated actions; there is no plan to work as a team’ (Expert C, 2017).

Government responsibility - elementary schools

Expert Q who is an industrial design leader at a University in Mexico, proposes that an important government responsibility for SD is education, adding that ‘the greatest impact would be through elementary schools’ and that ‘the Ministry of Public Education in Mexico has a new educational model, which should promote SD’.

Education

Expert Q highlights the role of schools and universities in driving SD and how universities are contributing ‘important efforts by offering new Undergraduate programmes that support sustainable development’. This expert observes that ‘when students are immersed in the subject of sustainable development, they *do* increase their knowledge’ (inquirer’s italics).

Expert F, who is a researcher and academic in Madeira, specialising in social innovation and design thinking, considers that an important driver for SD is education ‘in living and thinking in a sustainable way’. Expert S, who is a postgraduate Design course leader in the UK, reflects this systemic approach to education for SD, proposing that the subject 'is a philosophy’ and therefore ‘should be integrated into the design process’.

Civil society

> The main driver [for SD] is people. if people do not become aware and decide to make change in society, no matter how many public policies arise, sustainability will not be a reality.
>
> (Expert Q, 2017)

Expert P, regidor (councillor) of urban development in a city in Mexico, considers that civil society organisations are drivers for SD, because they are ‘playing an important role in positioning the agenda of SD in government actions’.

Social development supporting sustainable development

Similarly, Expert G highlights the ‘great cultural wealth’ of Mexico, ‘deriving from the [country’s] sixty ethnic groups’ and how this cultural diversity gives the Industrial design profession ‘a wide possibility in Mexico’ to ‘attend to social development’ and by doing this, to support sustainable development.

> The more we work on social development, the more sustainable development we will achieve. (Expert G, 2017)

In this context of cultural diversity, Expert G considers that cultural and educational objectives coexist effectively in Mexico’s universities and that the Industrial design profession ‘has a wide possibility in Mexico’ to support social development. For Expert G, developing products through supporting artisans and their craft methods and techniques can ‘benefit communities in poverty ... this can become ‘a huge niche’. Expert G provides an example this approach;

> In Hidalgo, students worked on a project to enrich crafts in aspects of packaging, quality, production and presentation. (Expert G, 2017)

Expert G proposes that ‘each geographical location in [Mexico] can be supported by design students from different universities.

Poverty and social inequality

Expert D , an industrial design professor at a University in Mexico states that poverty and inequity are factors that are obstacles to achieving SD.

Expert B, an industrial design international professor at a University in Mexico, argues that social and economic stratification is very marked in Mexico and that ‘this prevents people from worrying about something more than the problems of the day to day’.

Expert C considers that in developed countries ‘the base of the pyramid’ (the majority of the population of Mexico who are in the poorest socio-economic group) influences the making of significant changes from above’, and that in Mexico ‘this does not happen, because the base of the pyramid is insufficiently organised to be able to achieve a change’.

Expert K, a Brazilian industrial designer and former UNESCO counsellor, believes that a key driver for SD is the ‘fact that half of the population [of Mexico] is in the line of poverty’.

Knowledge of SD and education in society

The experts perceive a significant generational difference in Mexico with regard to knowledge of and dedication to SD. Expert R, who is a professor at a University in Mexico and whose doctoral studies focused on sustainability as a basis for educational models, considers that education is key to the development of SD in Mexico and that there is a deficiency of education in society.

Expert I, who is a professor at a University in Mexico, specialising in sustainable dwelling innovations, affirms the role of education in increasing students' and communities' knowledge of the importance of sustainable development, and proposes that 'through the universities we must increase research and development efforts;

> generating research projects from different disciplines that may have a social impact. For example, developing monitoring stations that allow us to create knowledge of the magnitude of the problem today.

Expert D, who is Director of the Industrial Design Department at a University in Mexico, considers that the increase in knowledge of environmental problems among young people is a key driver for SD.

This opinion is shared by Expert U, who leads a postgraduate Product Design course in the UK: 'young designers are more interested in sustainability than previous generations. According to this expert,

> there has been a mindset change in the last twenty years regarding SD. In the past the driver was new legislation that manufacturers had to comply with. At present sustainability is seen as an opportunity for innovation. (Expert U, 2017)

Expert I, who is an academic at Tecnologico de Monterrey and CEO of an energy efficiency and solar energy company in Mexico, observes that (in Mexico) increasing numbers of young people are dedicating themselves to SD and that this is 'helping to awaken peoples' conscience'.

> Five years ago, many people told me that to undertake sustainability in Mexico was impossible. It was unthinkable that solar panels could be installed in houses and that the Federal Electricity Commission would allow it. Now a lot of people have these panels in their houses, and they know it works'.

In contrast to the opinions of experts D and I, Expert B, who is an industrial designer from Poland, currently researching and teaching in Mexico, considers that young people's knowledge of SD is limited to 'a definition that is usually only linked to green design and eco-efficiency'.

Mexico environment

Some experts mentioned the natural resources of Mexico in the Mexico environment as a facilitator or driver for sustainable development in Mexico. Expert N, who leads an Architecture course at a University in Mexico, believes that 'one of the main drivers for SD in Mexico is:

> the country's capacity to generate adequate spaces for sustainability. We have very adequate land to implement wind and solar solutions. We have all climates, water and land.

Another expert who mentioned the environment of Mexico and its natural resources with a focus on research and development and SD laws is Expert I. She is an academic at Tecnologico de Monterrey, specialising in sustainable dwelling innovations who considers that Mexico's advantageous natural resources and climate are facilitators for SD; but that the country remains 'very far from what we should be in research, development, and sustainability law'.

Government, law and industry responsibility

Expert Q, who is an academic in Industrial Design at a University in Mexico and who has experience in innovating and developing new products and services, identifies the government (in Mexico) as a key driver for SD, but qualifies this by stating that the

Mexican government is limited as a driver ‘because companies and organisations view laws as an imposition; they do not really understand the importance of environmental care’. In this context, Expert Q argues that ‘impositions [from government] do not work; there has to be awareness’.

Expert E, who holds a PhD in engineering, territorial management by the Technische Universität München, Germany and Professor at a University in Puebla, argues that a driver for SD is the existing deficiency in Mexico of ‘the integration of government policy on sustainability, projects with companies, academia and society, necessary to generate systemic ideas’

Mexico environment and enterprises

Expert I considers that Mexico, ‘as a developing country, is generating among young Mexicans, the intention to start up new companies (or enterprises) and that this is a driver for SD. For Expert I, this is ‘in contrast to “old economies", such as Germany, where young people are not so keen to start up new companies, because they think that everything is already done’.

Expert I considers that ‘from the point of view of public policies, there are many initiatives and documents, but there is no real action in practice’.

Companies

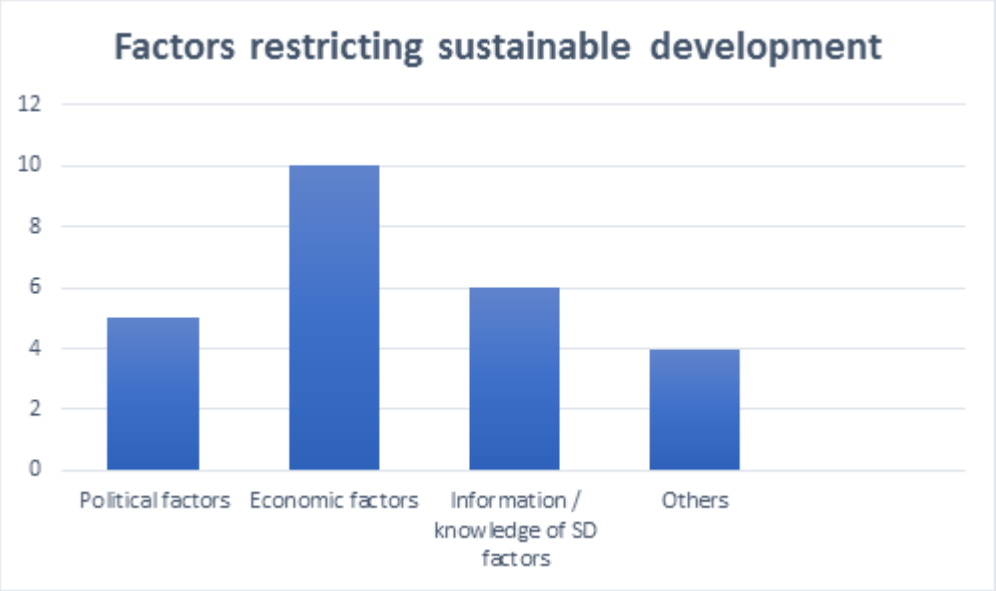
Expert Q, highlights companies with social responsibility programmes that are complementary to the creation of new products and services.

> I know many companies that have social impact programmes, in which sustainability is integrated, but it is a secondary subject and in some cases they do it to reduce guilt. (Expert Q, 2017)

Expert T, as an Industrial Design academic in UK Higher Education, highlights the curriculum content of Design courses, as drivers for SD, including ‘new materials and

processes that have less impact on the environment' and a module dedicated to 'design ethics' through which 'students explore materials and processes and reflect upon the responsible use of materials'

Question Number 2: Factors that are restricting sustainable development



The experts' answers to this question address a range of factors, which in the opinions of the experts, are blocking the progress of Mexico's sustainable development. The following record of the experts' answers to this question are organised according to four main factors; political, economic, information and other factors.

Political factors

Lack of government support for quality education.

Expert R considers that two factors are blocking SD in Mexico: government corruption and a lack of support for quality education. 'Teachers in public institutions in Europe are the best, here in contrast, public education is poor in quality, because of corruption'.

Note: perhaps this could focus on public education in Mexico?

Expert G states that ‘The lack of continuity in programmes, as well as problems of continuous planning in the government: the politicians want to show off personally - they erase the programmes initiated in the previous period. They do not continue them. Note: focus on lack of continuity in the government of Mexico’s education planning.

Expert K also argues that a lack of effective support mechanisms for small and medium-sized enterprises and corruption / loss of political authority, are blocking factors. He considers ‘internal factors’: ‘Low investment in science, technology and innovation’ as well as the ‘adoption of an industrial policy that privileges the maquiladora industry’. He (Expert K, 2017)

According to Expert M, government laws, the national development plan and public policies are not created from a point of view that considers integral SD. She considers that the projects of opportunities and the projects supporting the countryside, as well as the strong investments and tenders that are contributed to the construction of the big companies are based on the maximisation of the resources. ‘It's all business, increasing the gross domestic product without thinking about a regeneration of ecosystems.’ (Expert M, 2017)

When asked about the factors that are blocking or restricting SD, Expert J, who has worked in social projects in developing countries, argues that one of them is the government priorities and getting them to understand that sustainability is an important factor that requires attention and funding. He states that one challenge is to change the mindset of the politicians so they consider sustainability as a high priority issue. (Expert J, 2017)

Note: I suggest the above answers are condensed to form one or two short paragraphs.

Economic factors

Expert G also mentioned unfair interests of some business sectors as a blocking factor. (Expert G, 2017) Here, he agrees with Expert N, who mentioned business and commercial interests, in addition to the economic and educational issue as blocking factors. (Expert N, 2017)

Expert A argues that Mexico is following models designed by developed countries that are not suitable and sustainable for us as a developing country. ‘We have focused on models that generate short-term development and generate social pressure’. These comments on education, society and culture, link to Calvera´s view on the ‘peripheral approach’, in which there is a ‘dependency of models whether economic or cultural, coming from a centre’ (Calvera, 2006). Another issue Expert A highlighted is social inequality. A third issue is the weak Mexican institutions.- ‘the United States and Europe have more credible institutions with greater strength and with the ability to steer a course in the decisions that are made in the country’.

According to Expert I, the main factor is the economic one - ‘everything requires a justification of return on investment’. He argues that as long as social impact is not included as a priority factor in decision-making, we will continue refusing technologies for not being considered economically viable.

> There are many interests behind the economy, which are slowing down the transition to a green economy. One of them is the lack of education on sustainability. People still think it is an issue that we should consider in the future, they don't realise that it is a need in the present. (Expert I, 2017)

He referred to the community of Cuetzalan as an example - ‘they do not have pavement or electricity. If they learn about clean energies and recycling, we can prevent them from having the problems of a big city’. He concludes that we must not take the errors of cities to these communities. (Expert I, 2017)

> It has to do with training, not only in the aspects of hard skills, but with soft skills: these other skills that have to do with the social’ says the expert. She considers that a blocking factor is education in aspects of values, ‘it is necessary to educate the population about what our responsibilities as citizens are’. She states that decision makers have technical knowledge based on international agreements, but there is no real commitment to implement practical actions. ‘Moral and ethical issues are not taken into account’. She also considers that sustainable development is a matter of political discourse

> and not a reality. ‘In Mexico actions are isolated exercises of those who do have the will to make a change happen’. She also comments that we lack specialists who guide the process of sustainability. ‘There is no will of the politicians for change to occur’. (Expert C, 2017)

Expert Q agrees that the main factors are the economic and political ones. He argues that Universities and civil associations have the desire to support sustainability, but if the sustainable processes that accompany the production of goods and services are more expensive, we will hardly see them implemented. ‘Producers of materials insist on selling products that are not going to be recycled. It seems that we have to finish fossil fuel to worry about the use of clean technologies’. He believes that there are many economic interests of governments and companies so that these technologies do not give the expected results. ‘In Mexico, we have a structure of public policies that obey the interests of certain sectors, instead of favouring the sustainable aspect’. (Expert Q, 2017)

A great barrier according to Expert E is the neoliberal economic theme - ‘we are an individualistic and consumerist society … the few who want to make a difference and educate, face resistance from the majority of the population with a great lack of interest in the needs of others’. (Expert E 2017)

When asked about the factors that are blocking SD, Expert P responded: 'paradigms, bureaucracy and written rules that ridiculously many people within the government by inertia or laziness refuse to review'. Expert P argues that she knows many examples of situations where the government could not solve a problem related to SD, simply because the wording of a law was unclear and they refused to change it. ‘This situation has slowed the promotion of investments in technologies that could help us reach sustainability.’ Expert P argues that there are many economic interests. ‘There are many companies that have invested in machinery to work in a certain way, therefore, when you propose a new machinery with ecological benefits, they reject it because it is very expensive to replace it’. For these reasons, expert P considers that the governmental structure coupled with business economic interests are factors of delay. (Expert P, 2017)

Expert B explains that ‘poverty in Mexico surpasses 50% of society, it is a large country where 60 million people live in poverty’. According to her, globalisation focused on turning Mexico into a manufacturing country, preventing the development of sustainable proposals - ‘there is a lack of promotion of sustainability concepts’ and ‘there is a lack of pride to promote local proposals before the international ones’. She argues that we should not copy, but to adjust proposals to the local context. (Expert B, 2017)

According to Expert H, we are working with ‘outdated models’ and that we need to promote circular economy. ‘We are educating people separately into thinking very traditionally about particular disciplines’. She argues that one of the ‘biggest issues that we should consider is the systems thinking and collaboration’. (Expert H, 2017)

Information (knowledge of SD) factors

For Expert A, the information culture in Mexico is an obstacle to SD as it results in people not knowing what sustainability means and therefore what role they can play as citizens.

A fourth issue, for Expert A, is the information culture in Mexico, people do not know what sustainability means and what role they play as citizens. (Expert A, 2017)

Expert D considers that ignorance and mistrust are two factors that are blocking SD. He states that this is due to a lack of legislation on sustainability. ‘In developed countries, there is a punishment for those who do not comply’. He proposes that ‘programmes are needed that give real benefit to communities - people do not have time to test whether a sustainability programme works because their concern is to feed their children - they cannot take a chance’. (Expert D, 2017).

Expert L states that a blocking factor is the lack of awareness - ‘we are so used to having natural resources that we do not realise reality … we are about to run out of water and it is very expensive to bring it from other zones, yet people have no idea that we have this problem’. According to Expert L, people are not aware that only 1% of the water on the planet is potable. ‘There is no education about it, elementary schools do not include it in their programmes’. In Norway, garbage does not exist, it is an input for something else’. Another blocking factor for Expert L is corruption - ‘there

is no supervision of these laws'. Expert L also commented that 'we are not using the technology and advances in innovation' to solve this problem. (Expert L, 2017)

According to Expert O, one factor that delays SD is that we do not have a complete and correct definition of what SD means. 'It is a concept that in Mexico is still not well understood, people think that it is only about protecting the environment, they rarely include the social aspect'. Expert O considers that we lack more diffusion and understanding of what this concept means in its depth and in all its dimensions and 'that makes some of the funds, research and work of companies have a partial reach'. He argues that there are companies that are incorporating the concept of a socially responsible company, but in a very superficial way and only for the sake of image. They do not transform the way they operate. (Expert O, 2017)

Expert F states that if the different stakeholders become more aware of what SD is, and how it impacts on the life of people and future generations, they will be more interested in investing for this purpose. 'There are higher levels of decisions and agreements between industry and the politics that people do not see, and that impacts on people and life'. She argues that most people take things as they are and do not want to make much effort and that is why it is so important to get them understand the value of sustainability - in the way of 'doing things, living and thinking'. (Expert F, 2017)

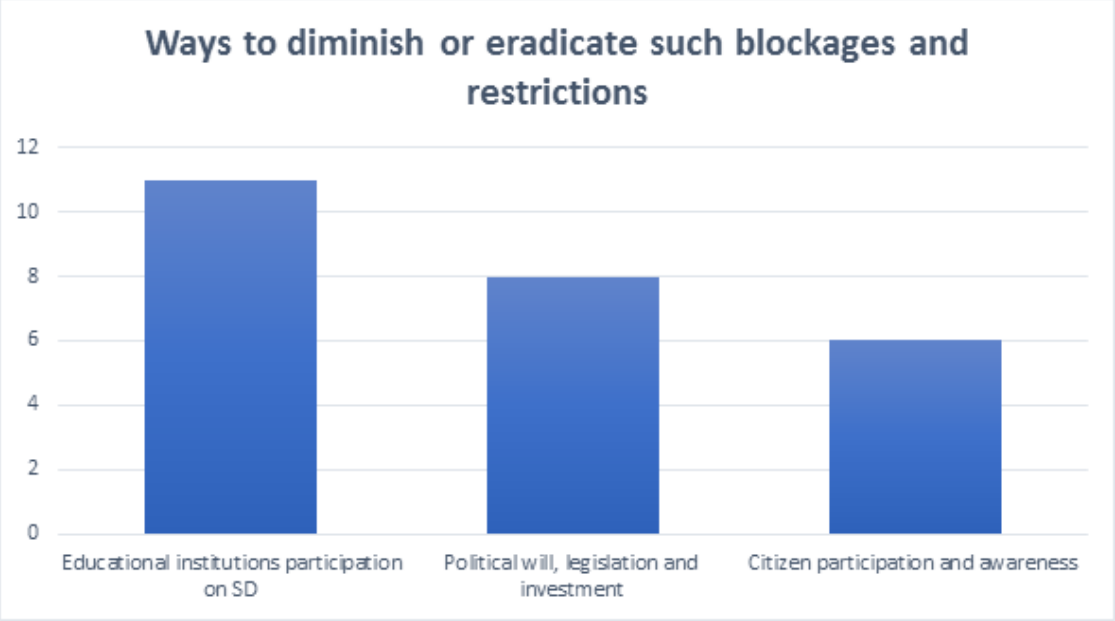
Other factors

According to Expert U, a retarding factor is the fact that the young designers and young consumers are concerned about SD but they are not empowered yet. 'If this tendency continues, in 10 years there will be a new role that can make a massive change'. He believes that 'this young generation is not yet empowered but maybe in ten years they will be able to make a real change'. (Expert U, 2017).

Expert T argues that a blocking or retarding factor is that the big companies have certain established models of operation and it is very complicated for them to change. He also states that economics plays a big part - 'there are people in less developed countries whose priority it is not sustainability'. (Expert T, 2017)

> I think the big problem I see is a lack of political will and commitment to support these issues', states Expert V. As an example, she proposes that there should be a greater government investment on cycling infrastructure and less investment in roads. Guidelines of the national government. Economy. (Expert V, 2017)

Question Number 3 Results. Ways to diminish or eradicate such blockages and restrictions



In the next section, the responses of the experts on the ways to diminish or eradicate SD blockages and restrictions are presented, they were organised into 3 groups: 1. Educational institutions participation on SD, 2. Political will, legislation and investment and 3. Citizen participation and awareness. One remarkable response is the one by Expert A, he considers that a great solution would be to create a sustainable model where development resolves tensions between development and the long term; a model not copied from another country, but designed for our own reality. 'We need initiatives and policies that allow the gap between rich people and poor people to be narrowed'. (Expert A, 2017)

Educational institutions participation on SD

Expert L emphasises that sustainability education should start from elementary schools, not at a specialty level. ‘Being aware of the problem makes us all, supervisors, rather than waiting for the government to take action’.

Expert N agrees with Expert L - ‘in order to eradicate or diminish the problems of SD in Mexico, we mainly need an educational programme that emphasises sustainability issues starting at elementary schools. (Expert N, 2017)

Another person who agrees on this point is Expert R. She argues that the problem remains the lack of education - ‘in poor communities, people have no elementary education’.

According to Expert O, one way to reduce the problem is through ‘communication and education’. He also believes that today in Mexico ‘children and young people are more aware of the issue’. (Expert O, 2017)

For Expert F, ‘we need to create this culture not only at the University level, we need to start before’. She argues that education and creating a culture around sustainability is the first step. Expert E, thinks similar, she refers not only to the education we receive at University, but also to the education we receive in our homes ‘the answer lies in education … without education we cannot advance to a better future’. (Expert E, 2017)

Like many of the other interviewees, Expert Q also considers that education is a way to eradicate SD restrictions. He states that education must ‘permeate our children and young people so that when they reach adulthood, they care about the environment’.

Expert G argues that universities must take command of SD programmes - ‘not government, not companies, but universities must do this by joining civil associations, working as a team’. (Expert G, 2017)

> ‘The effort of the universities must continue, the path is very slow, but they are the ones who can find projects that address the sustainable theme, give

executive training to the government and external organisations on the relevance of environmental care and sustainable processes'. (Expert Q, 2017)

Expert C proposes the design of projects at Universities and working in team with civil associations. 'We need to rethink what is taught in elementary schools'. She has the experience of trying to implement sustainability projects in this schools - 'unfortunately the educational programme of the Ministry of Public Education is so strict that it does not allow exploring sustainability'. She comments that this topic is only addressed as part of the subject matter of biology, not as an objective. She also states that the teachers are very sceptical and fear that if they use time on the subject of sustainability they will not comply with the stipulated programme. She also comments that vulnerable communities are willing to change because they know that if they do not change they will run out of portable water, in contrast with urban areas, where it is more difficult for people to realise the need to address the issue of sustainability. 'Education must make clear the danger and risks of not being sustainable through critical thinking. It is necessary to work in teams, to develop collaborative projects'. (Expert C, 2017)

According to Expert M, the problem must be addressed through academic and family education - 'that both civil and educational organisations promote a more sustainable integrated education'. (Expert M, 2017). Expert J also proposes that one way to diminish the problem is by educating people. (Expert J, 2017)

Expert H proposes that we need to change the way we are educating the next generation. 'The traditional model where someone goes to University to study one discipline, is not working anymore'. She argues that we need to teach students the complexity of systems. (Expert H, 2017)

Political will, legislation and investment

Expert K proposes that we need a 'change of political mentality: socially, culturally and environmentally more responsible'. He proposes the adoption of meritocracy in delegations of responsibility as well as extending public and private investment in innovation processes, not only technological but cultural. (Expert K, 2017)

According to Expert S, the main ways to diminish or eradicate blockages against SD is by promoting adequate legislation and by the ESD at all levels. (Expert S, 2017)

Expert D also proposes that a way of diminishing blockages is by applying the law - ‘it is useless to have laws that are not going to be fulfilled’. Expert D also states that marginalised communities have more attachment to nature and would be more willing to implement laws, but at the same time, poverty limits them. ‘We need to invest in SD programmes for low-income communities’. (Expert D, 2017)

Expert R states that we need the government to ‘stop cutting resources for education, as it is doing, and invest more in education’. According to her, the problem is ‘the issue of corruption’ and that ‘institutions steal money invested by the government, money does not get where it should’. As commented before, she argues that the problem remains the lack of education - ‘in poor communities, people have no elementary education’. Poverty accentuates the problem, as the Maslow's Pyramid shows, we first cover basic needs. ‘People cannot seek SD when they are worried about what they are going to eat. It is sad that only in Education, we are more than 10 years behind Europe’. (Expert R, 2017)

Expert J proposes that one way to diminish the problem is by convincing the government of the benefits at different levels of this issue so they can see value in funding projects. (Expert J, 2017)

Expert Q considers that one challenge is how to ‘raise awareness in political parties’, so that they ‘give priority to this issue’. He believes that it is difficult to change politics in Mexico without an agenda of protection to the environment - ‘we have the most polluted cities in the world and yet the environmental theme is not part of the political agenda’. (Expert Q, 2017)

Expert B considers that we cannot speak of a single solution but a system of solutions. ‘Mexico is very focused on an economy of gross growth and there is a lack of other alternatives such as collaborative consumption’. She argues that there is an economic and social problem due to poverty and to the economic dependence of the oil industry and the US market. She also states that there is a lack of laws to protect

the environment and that there is a lack of education on environmental issues. (Expert B, 2017)

According to Expert T, an important way of eradicating blockages is through political will and the will of companies to address SD. ‘There may be a political will but companies may not have a will, they need to redefine the whole structure’ states Expert T. He argues that if companies could see the benefits of sustainability as the way they are perceived by the public, they would be more willing to change and that companies should plan a way to repurpose all the parts of the products after disassembling them at the end of its life cycle. (Expert T, 2017)

Citizen participation and awareness

> ‘It is a responsibility of all, culture reaches our homes, colonies, neighborhoods; The culture of separating garbage, caring for plants and animals, reducing the use of cars’. (Expert Q, 2017)

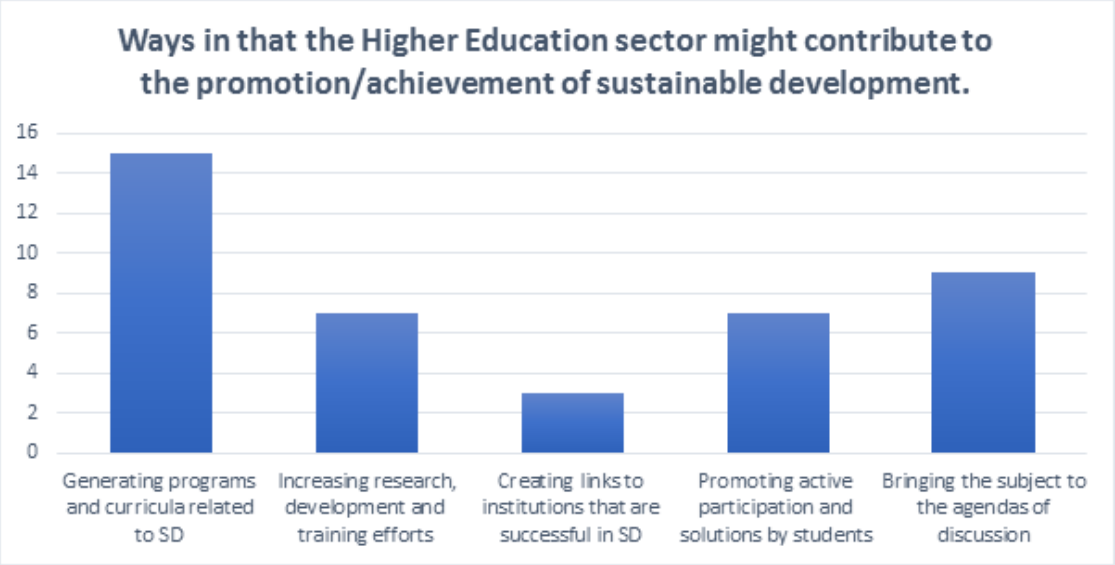
According to Expert O, one way to reduce the problem is by creating a network to better disseminate SD concerns, to be able to do a’ better job of promoting and defining objectives and goals’. He argues that collaboration between different concerned actors is needed to work on the best definitions and in ways to solve it. (Expert O, 2017)

Expert U argues that a real change would come from the bottom and not from the top. ‘I think if you work in a company or University that is open to include broader views and to listen to young consumers and designers, that might help’. He also believes that we need a massive change, and that the young generations are the ones who would be able to press the politicians. (Expert U, 2017)

Expert P argues that ‘social pressure and citizen participation are unlocking sustainable issues in Mexico'. (Expert P, 2017)

‘We must measure the social impact in terms of economy and decision making to raise awareness of the importance of SD’ argues Expert I. He refers to the Atoyac River as an example - ‘while the only concern was the bad smell, no one cared, but when studies and data of people who are getting sick and the problems of having a dirty river appeared, society began to consider the cost of not solving it’. According to Expert I, in Mexico we still see SD as expensive, something that we cannot achieve. ‘If we become aware then we will begin to see it as a necessity and not as an expense’. (Expert I, 2017)

Question Number 4 Results. Ways in that the Higher Education sector might contribute to the promotion/achievement of sustainable development.



Generating programs and curricula related to SD

Expert N considers that the higher education sector can contribute to SD from two avenues: ‘1. Generating undergraduate curricula related to development and environmental protection. 2. Incorporating the sustainability issue in all educational programs’. (Expert N, 2017)

According to Expert D, students should also learn how to measure sustainability, eg: gallons of water saved, degrees of temperature saved, etc. (), 2017)

As a graduate of Tecnologico de Monterrey and as a person immersed in the subject of sustainability, Expert I believes that the approach of universities should be to make it an obligatory subject that every graduate must master. ‘Students should understand that as long as they are part of the economic life of the country, they must be in line with SD.

According to Expert D, ‘The role of higher education is fundamental, without them, it is difficult to translate change into reality’. She considers that empirical knowledge has made many rural organisations succeed, but without specialisation towards organised ways of making it real, it is very difficult to make a change. ‘All undergraduates must have sustainability as a common goal, lawyers, administrators, designers’. She states that it should be part of the objectives of all curricula.

Expert P argues that higher education institutions can do much: they can include the issue in the curricula, promote awareness, and promote citizen participation.

Expert J mentioned that one way that Universities can contribute is by considering this issue more firmly in the syllabus. (Expert J, 2017)

Expert U suggests that one way in which Universities could contribute is by offering more programmes / masters in Sustainable Design and also by including more of these contents within the Product Design curricula. He also proposes that professors give the students sustainable approaches in whatever they are designing instead of only pursuing aesthetical issues; and to allow students to pursue their personal choices. (Expert U, 2017)

One way in which Universities can contribute, according to Expert T, is by having design courses and specific modules to get students understand and address sustainability issues. (Expert T, 2017)

Expert B argues that what universities can do is to rethink the problem - ‘we should not treat it as something extra but as an integral part of the curriculum’. (Expert B, 2017)

Expert W proposes ‘real-time remote classes’. She states that despite Design students needing personal feedback from their professors and manual processes, real-time remote classes have given enough results to continue. ‘We have worked with the model for 5 years now. With this scheme of classes students can receive

knowledge from anywhere in the world as this system eliminates boundaries'. Expert W proposes that this model supports sustainability in education, as 'it is economically profitable to have access to experts from other countries simultaneously'. (Expert W, 2017)

Increasing research, development and training efforts

Expert I, on the other hand, suggests that Universities must increase research and development efforts, generating research projects from different disciplines, for example, monitoring stations that allow us to create awareness of the magnitude of the problem. 'In Mexico, when IMECA was first published, the problem of contamination was understood for the first time. Before it was monitored, there was no awareness of the problem'. Spreading the information that is obtained from the environmental monitors would allow Universities to raise awareness. This a way to contribute'. (Expert L, 2017)

Among other proposals mentioned later, Expert A proposes 'Assuming the role that each one has, the University: generation of knowledge, cutting-edge research'. (Expert A, 2017). And according to Expert D, one way of achieving this is by training professors in Universities.

Expert Q considers that Universities should focus on 'developing new technologies, designing more sustainable products and services, raising awareness in large companies and governments for the creation of sustainable public policies'. (Expert Q, 2017)

Expert B implies that more training on SD to professors is needed. She argues that many teachers are unfamiliar with the design theme for sustainability, 'including the concept is difficult because few teachers know it.' (Expert B, 2017)

Creating links to institutions that are successful in SD

According to Expert D, one way of achieving this is by 'creating links to companies that are successful in sustainability issues'. (Expert D, 2017)

Expert G proposes a ‘focused social service’ to avoid isolated efforts. ‘Civil associations bring together experiences and should work with universities, commanded by universities’. He recommends an inter-University social service, ‘the ideas of many are better than those of one’. ‘We should avoid isolating ourselves in our disciplines, we should make inter-University projects and inter-disciplinary projects’. He also proposes to enrich the curricula by including social anthropology studies to sensitise students and prepare them for the focused social service. What is more, Expert G proposes that Universities work with social anthropologists to help us discover real communities needs and the best ways to help them; and that Universities should give resources to each regional rectory and build a team of people working for social development. (Expert G, 2017)

Expert Sevra H proposes that Universities work closer with industry through incubators accelerators and innovation units. ‘It has to do with how we teach students, we still teach product design and architecture as singular isolated disciplines, in a 20 century model’. She also argues that in her opinion Schools need the participation of big collaborative teams and expertise. ‘Students are getting trained in one way and they find a different reality when they graduate’. (Expert H, 2017)

Promoting active participation and solutions by students

Expert D states that we must teach not only in a theoretical way, but also in an ‘experiential way’, by promoting the participation of students in real projects that give them the opportunity to see how companies approach sustainability.

Expert I states that SD should not only be a subject as it is today, but ‘an obligation of all of us who belong to the small percentage of Mexicans who had the privilege of having access to higher education’. This expert argues that a total integration is missing. Teachers should not give the option of being or not being green, ‘the only option is to be green’. ‘In the 21st century it is absolutely necessary to rise to the sustainable wave in order to have a future’. (Expert I, 2017)

Expert T states that the most effective strategy would be getting sustainability into the ‘mainstream’ of the programme by promoting within the student active participation and the generation of possible solutions. (Expert T, 2017)

Expert F, proposes developing projects outside the classroom, going out and asking questions to ‘open people eyes’. These strategies promote not only the awareness of students but also of citizens, as they see the students working in open spaces in the communities. She proposes replacing the classic learning model where students remain inside a classroom most of the time. (Expert F, 2017)

According to Expert D, we need to ‘analyse how we can connect the needs of communities with universities, these must be the bridge between knowledge and real need’. (Expert D, 2017)

According to Expert K, we need to have a ‘long-term vision’ defining in a clear and understandable way the future we aspire to, a ‘development model intended for the country’. ‘We need to teach students to have a more citizen-oriented view of problems and to be less selfish’. He proposes that we should make the ‘trinomial teaching / research / extension a reality’. Expert K proposes the definition of ‘indicators of economic, social, cultural and environmental impact’ as well as developing methods and tools to ‘measure the results of projects and actions’. (Expert K, 2017)

Expert J states that one way in which the higher education sector can contribute is by working with young people and taking advantage of the fact that there is a high potential in them to change the problem - ‘young people care a lot’. One of the developing countries where he has worked is India, he suggests that young teachers, in their early 20’s are very motivated and really want to make a difference.

Bringing the subject to the agendas of discussion

According to Expert Q, the Universities open the way in the consciousness of companies and the government to consider with more force the sustainable subject, ‘the Universities bring the subject to the agendas of discussion’. ‘They are doing a good job, but it is insufficient - we have to reach the citizen's conscience’. He considers that Universities should focus on developing new technologies, designing more sustainable products and services, raising awareness in large companies and governments for the creation of sustainable public policies. ‘We must redouble our

efforts to reach the citizens, to create programmes with the purpose of raising public awareness'. (Expert Q, 2017)

Expert E focuses on higher education as 'the key sector and key actor' as 'the academy is the one who can summon the society, the government and the private initiative'. 'Few Universities are aware of this important role they play in society'. She believes that what the rector says is taken seriously, contrary to what happens with politicians and that universities have a level of respectability that must be seized. 'Unfortunately, universities are jealous of knowledge, we do not share it, we do not want to contribute anything more than just professionals'. She reflects that we need to work on alliances between universities. (Expert E, 2017)

Expert A proposes 'transferring, putting knowledge into the hands of society'. He states that in education this topic 'must be transversal, it cannot be an isolated subject, it must be an issue that impacts on the whole curriculum, based on our own models'.

> In our country, given the inequity and lack of culture, the University has a responsibility not only to play its role, but to be the arena for convergence, discussions and proposals'. (Expert A, 2017)

For Expert R, 'Higher education has an obligation to help society and to contribute through education'. She argues that the greater the academic degree of a person, the greater is their obligation to give back to their society. 'We have a responsibility to favour those who did not have the opportunity to enter higher education'. (Expert R, 2017)

Expert P argues that higher education institutions can promote citizen participation. She also suggests that it is the government that has the resources and they are the ones who make the rules - 'that is why we need a strong and ethical government'. She has known that there are many very conscious entrepreneurs, who hire companies to clean their water. The problem is that these companies collect the water, charge their money and then go and throw the polluted water to the Atoyac river. (Expert P, 2017)

According to Expert O, one way in which the education sector can contribute is by addressing these issues from the different disciplines as it is not a subject that

belongs to a single discipline. ‘High schools should have the subject on the agenda through projects, activities and in the operation of the University, in order to be congruent’. He proposes working at different levels: basic education can tackle the issue from awareness raising, middle school through intervention projects in community work, and at the University level with the development of skills and competencies of students from their professions. (Expert O, 2017)

Expert M argues that higher education is a fundamental axis and it is the bridge between companies, government, academia and civil society. 'The academy is the incubator of new strategies and academic, economic and environmental proposals to educate citizens'. She also sees the University as where the development of new strategies can be facilitated and where new politicians, entrepreneurs and citizens are formed. (Expert M, 2017)

According to Expert F, people do not know what SD is and that is why the first step is to ‘create a culture of sustainability, so that people understand the potential of design from a product, service, strategy and social point of view’. (Expert F, 2017)

The perspective of Expert V is that traditionally Universities have an important role in providing information to the society. As an example, she mentions that sustainable construction is not a priority for companies but universities can insist on its importance. She believes that lectures have a voice in this issue and that we should teach students about our planet and its ability to sustain us. (Expert V, 2017)

According to Expert S, two ways in which the higher education sector may contribute to the promotion and achievement of SD is by holding conferences and inviting decision makers and the government. (Expert S, 2017)

Question number 5 Results. What are the current ‘big issues’ or open questions in relation to sustainable development?

According to Expert D, one big issue regarding SD is that indicators are not easy to read. In Mexico there is no exact information about the carbon footprint caused by the citizens. ‘Students should note that their small effort has a measurable effect: for

example, the increase in a family's income'. Expert D has noticed that organisations with which the universities work, sometimes get disappointed - 'at the beginning the students delude the community, but once the project is delivered and the note is given to the students, they do not follow up'. Expert D argues that the communities must be told that the follow-up of the project is in their hands. (Expert D, 2017)

Some open questions that Expert G proposes are: 1. Where to start? (Addressing social inequality, ecology education in communities). 2.Shall we begin at the root of necessity or attend to the effects of that? 'We could meet the two questions in parallel' states Expert G. (Expert G, 2017)

The issues of study states by Expert L are the following: 'Glocal' vision, 'a solution that arises from the local and has an impact that transcends to a global context'. She proposes that given the globalisation in which we live we must take the advantages of what is already known and be applied to them in different contexts. 'We need to take responsibility for generating research from our context and take into account all that is already known at the international level'. She also recommends that it is important to analyse how we will follow up and respond to agreements reached at conferences such as ONUHABITAT 2016, which generated a list of recommendations and challenges to be met by every sector of society, including universities. (Expert L, 2017)

Expert N considers that an open question regarding ESD is the following: What path do we want sustainability to take in our country? 'There are several types of approaches, from very technical to very agricultural; the other major approach is how to implement the theme of SD in the different disciplines'. (Expert N, 2017)

A big issue proposed by Expert W is: Are students receiving the right education, to be the future professionals that the nation needs and to really contribute to the SD of the country? (Expert W, 2017)

According to Expert R an open question is: 'How to design not to create a new need but to solve existing and urgent needs of society'. She states that we need to be able to identify the current needs to be able to innovate. 'It is necessary to make an assessment, and an evaluation of all aspects that influence the development of education to detect what is needed'. Expert R proposes that we must also make a comparison with countries that are doing well, to detect what we are doing wrong and

what we can improve. ‘The Catholic school in Chile has grown a lot because they are inviting professors from all over the world, who bring experience from their countries’. (Expert R, 2017)

For Expert K, a big issue is the reductionist and / or mechanistic view of problems as opposed to a systemic view. ‘Educating for citizenship and entrepreneurship’. (Expert K), 2017)

Expert A considers that we need to formalise the theme of SD as a transversality, ‘something that any curriculum must include intrinsically in its discipline, not as an aggregate or as an extra subject’. He states that this topic should be consistently present as a frame of reference in education at different levels, and should start from elementary schools. ‘We cannot wait until the students arrive at the University to teach it because it is too late’. (Expert A, 2017)

Two big questions, according to Expert I are: Why don't we understand the importance of this? How to make each and every person aware? (Expert I, 2017)

Expert C argues that SD continues to argue that development equals growth, even though there is a huge contradiction between sustainability and growth. ‘The economic model that we follow is one of the main obstacles to change’. An open question is: ‘How do we really involve sustainability without thinking about the international paradigm?’ She argues that those who dictated the development perspective left out most countries. She also argues that today we can see countries with a high GDP also have a high suicide rate, because they are looking for economic growth without worrying about the well-being of people and their personal development. ‘Bolivia, has another position, they use public policies that do not seek economic growth but quality of life’. She also argues that politicians seek to satisfy their egos instead of satisfying the common good and that the techno-centric vision does not necessarily work for our reality, we should not look for cleaner technologies but prevent and fight pollution. ‘We are consuming more resources than nature can give us’, that is why another proposal is the ‘degrowth model’ whose objective is to analyse how a country can decrease to anticipate an imminent crisis and in that way the damage of the crisis is smaller. ‘The University of Barcelona is investigating this issue deeply from its School of Economics’. Expert C states that there comes a point in the country where it can no longer grow for different reasons, for example, because of the lack of oil. This leads to economic crises, so before reaching that point we must

design a model that allows us to be prepared, to decrease voluntarily instead of waiting to decrease by the crisis. (Expert C, 2017)

According to Expert Q, the main open questions are the following: 1. ‘When will we reach a global alignment where all countries agree that sustainable design, sustainable technologies and respect for nature is a priority?’ He argues that countries such as the United States have capabilities that lead them to have a large plan of action, countries like Africa may have smaller plans, but all countries must have aligned plans, according to their capabilities. 2. ‘When will the interests of the business really be equated with sustainable interests?’ 3. ‘When will there really be accessible processes that can be integrated into product development and innovation?’ 4.’When will companies bring technology developed by them that is not focused solely on the monetary issue but on changing the world?’ 5. ‘When are we going to have such processes implemented in large and small companies?’ (Expert Q, 2017)

Why does the government continue to cut back on the education budget? That is a big issue, according to Expert E ‘As we have just seen, there was a cut to the Conacyt (National Council of Science and Technology) and this is not consistent with the national development plan’. It is very clear that the most developed countries in the world have invested in education, so there are some open questions here, 1.’Why is it not a government goal to reduce illiteracy?’ 2. ‘Why don't we have a greater society commitment? Why aren't we demanding more from the government?’ 3. ‘Why were there no protests after the cut to education?’ 4. ‘Why do we not present proposals to our deputies?’ 5. ‘Why is Mexico's participation so low?’ (Expert E, 2017)

According to Expert P, we have an economic model that is leading us to consumerism and that goes against sustainability. ‘We need to find the midpoint’ she states. Another open question she adds is the next: Why do citizens belonging to big cities not care about the environment? ‘If you go to small indigenous communities where people do not have basic education, you can see the love and respect they have for nature. People in the cities have become insensitive. (Expert P, 2017)

‘We need a complete and correct definition of what sustainability is’ states Expert O. He proposes the next two open questions: How are we going to train teachers? With what criteria and principles? He mentions that Tecnologico de Monterrey already has training efforts, through CADIs (courses to updated professors in their discipline) and

through programmes that seek to enable all teachers in a certain knowledge of SD to introduce it transversally in subjects. (Expert O, 2017)

According to Expert B, the main open question is: How to unlink the SD issue from the current economy? 'Which is based on continuous growth that is unsustainable and is not viable'. (Expert B, 2017)

'How to adapt the curriculum to practical sustainability?' How to link the subjects throughout the undergraduate so that they are not isolated and can develop interdisciplinary projects that promote SD?' These are the main open questions regarding sustainability, according to Expert M. (Expert M, 2017)

Expert J proposes running workshops with communities as well as investigating and tackling problems such as unemployment in order to get people interested. 'People want to see tangible results, something that is useful and can be applied'. One of the big issues according to him is how to get funding from local stakeholders to continue developing the projects. 'Going back and trying to convince people of the future impact'. (Expert J, 2017)

In Expert F's opinion an open question is: 'How to make society actually aware of the importance and urgency of sustainability?' 'Not in the point of view of catastrophes, or with the purpose of generating fear, this is not useful, people get shocked and then they forget it and do nothing.' A second open question in her opinion is: 'How to convince the industry to invest in new materials, new technologies?' (Expert F, 2017).

According to Expert U, even though the main change will come from the bottom, a key issue is politics, 'If we look at the current international situation climate change is going to play a massive role, but politicians are still not sure if this is going to be a key issue, they are still discussing it and it is difficult to come up with a convincing answer in the short term'. (Expert U, 2017)

Expert T states that for companies it is very expensive to change their current technologies to generate less impact to the environment. He also argues that currently it is very expensive for companies to reuse elements. For him, an open question is: How do we deal with the current electronic goods in a simple and easy way? (Expert T, 2017)

SD is a contradiction in the term itself, and it is a contested issue, states Expert V. An open question would be: What do we mean by SD? (Expert V, 2017)

Are we able to truly collaborate and think in a systems way? This is the biggest worry in Expert H's opinion. She also worries about how to change economic models and how to move to a circular economy. (Expert H, 2017)

According to Expert S, two open questions in relation to SD are: the definition and right interpretation of Sustainability and its right application into the design process. (Expert S, 2017)

Question number 6 Results. If you have been involved in sustainability-oriented innovations, how were these designed, how did they perform, what made them successful, and what was learned from the process?

Expert D participates in social projects in his Product Design course where students design for artisans. 'The main challenge is the economic issue, people are in a situation of poverty, they do not take risks, and if they take risk they do not do it in a comfortable way, they could lose a lot'. He also participates in a project that involves a modular furniture system to promote the participation of a marginalised community. 'If you develop a project, it is important to visit them 6 months after working with them because to see if you really generated a change, it is very important to follow up'. (Expert D, 2017)

'Land of Artists' is the name of a social project carried out with several Universities. Its slogan is 'art for a culture of peace and non-violence'. Expert G argues that communities are afraid of being used, that is why they use a full month to generate empathy and to gain trust. 'People who have been hurt by false promises need to believe that Universities are not coming to get something, but to serve'. Expert D considers that it is recognised that what artisans do is a valuable art that must transcend future generations. They started painting murals in poor communities and now they build hostels and lead craft projects. 'Civil Association + University = valuable and lasting results'. According to Expert G, we must empower our graduates through civil associations. He recommends hiring a social anthropologist at every campus, or at least by region. (Expert G, 2017)

Expert L is participating in ‘Iniciativa Ciudadana’, an organisation that works to help migrants to generate SD in Mexico so that they do not have to leave the country. Students of the course ‘Energy Efficiency’ designed an orchard for a High School, they made a manual to build an urban garden appropriate to the conditions of the community. She also works in a project with the Neowatts company, where the students designed a green kiosk to charge cell phones and computers. She proposes that a key is ‘having an external partner who gives seriousness to the project’. She also recommends giving students the opportunity to interact with people. ‘The real projects go beyond the rubric when you manage to engage the student with the need of the community’. She concludes that true learning is seeing how your learning makes a difference in the lives of real people. (Expert L, 2017)

Expert W is participating in the FIT courses programme at Tecnologico de Monterrey, FIT means flexibility + interaction + technology. ‘This a very important effort for sustainable education since in the first instance it gathers the knowledge of several subject matter experts’. Professors share opinions and develop material to make a “seed” course for other adopting teachers. In turn, these adopter teachers will enrich their courses with their knowledge. (Expert W, 2017)

Expert R generated an evaluation methodology to qualify the University education programmes based on sustainability through different criteria that were applied in the subjects of the curriculum. ‘I did an analysis of the best universities in the world, to identify what they had in common: their programmes considered sustainability since the first semester’. She argues that the best University identified, focuses the entire first semester on the subject of sustainability. (Expert R, 2017)

Expert K has participated in projects based on a mode of approach advocated by the Design: Focus on the individual and on real problems and local conditions (vocations, potentialities and desires of its inhabitants); Participatory learning / teaching processes; Sharing of decisions with strategic partners; Projecting ‘with’ and not projecting ‘to’; Measurable goals and outcomes over the long term; Respect to diversity; Valuing culture as inalienable heritage. (Expert R, 2017)

Expert A comments that at Tecnologico de Monterrey, campus Guadalajara, they choose each year one of the development challenges declared by the United Nations and we include it in various groups of multidisciplinary students from different campuses to solve the problem. The overall objective is a dialogue between

disciplines and realities, for example, water scarcity or hunger, all are related to transformational methodologies. ‘We go to poor communities, we do not limit ourselves to analyse the problem in a theoretical way, we apply the methodologies: design thinking, user centred design, empathy’. He considers that they seek that the students understand the problems of the communities and generate sustainable models co-created with the communities. (Expert A, 2017)

‘When we started 5 years ago with the topic of solar energy we saw a lot of lack of interest in people’ comments Expert I. At his company they decided to launch a strategy totally focused on the economy: ‘we adapted to the market mindset because people were not interested in environmental care’. Once captured as customers, we create awareness’. Expert I argues that they learned that the company can take advantage of the environment in which we live dominated by ‘supply-demand’ and that we can gradually create awareness and generate a benefit to the planet. (Expert I, 2017)

Expert C has participated in a project to redesign a neighborhood in Helsinki, ‘a neighborhood considered the least privileged, full of migrants, who come to look for work’. ‘It has all the services, it works well, but the government asked the University a plan so that by 2075 the neighborhood reaches its maximum potential’. They worked with the fashion school because ‘they have an enormous tradition of generating and studying trends’. The University got a house inside the neighborhood and the students moved there. ‘Each team had a room, in my team we investigated climate change, wars, migration movements, technologies that would exist, political changes’. Expert C argues that they created scenarios, worked with the community, held participatory design workshops to see what people wanted to change and what they wanted to stay. They designed a University city as an ideal setting to reach the potential of the neighbourhood. (Expert C, 2017)

Expert Q has worked on the design of products that had to do with sustainability: refrigerators that pollute less by use of refrigerants and blowing agents, products that fulfil their function by consuming less water and materials.

> ‘However, we are immersed in an economic system where indicators are purely economic, organisations end up renouncing the sustainable issue in

> order to compete in the market. More technological generosity is needed: if I develop technologies aimed at sustainability, I must share them with other organisations so that the impact is greater. This is very complicated, the company that makes a very high investment, wants to exploit its innovation and recover the investment. We need a change of mentality. We can balance the economic aspect with the impact to the environment through Design thinking, circular economy, new technologies and assembly processes.' (Expert Q, 2017)

Expert E has experienced community workshops with her students, 'after the students had contact with a poor community, they change their mentality, they begin to worry about solving needs'. A success factor in her opinion, is to work in a multidisciplinary way, 'we organise workshops with teachers from Germany, TEC Monterrey people, BUAP and IBERO from different disciplines'. She states that learning should not be only theoretical but practical enough to generate commitment in students, so that later in their work life they consider in all their projects the social approach. 'We must involve academia, students, and the community'. From the experience with teachers from Germany, she learned that it is very important to implement participatory planning strategies, to do an analysis of social actors and the link with the government.

> 'In private universities we inadvertently make students fly very high and do not land them to the needs of their country: we make them internationally competitive, innovative, bilingual, with a global profile; But we forget to create sensitivity to local needs. (Expert E, 2017)

According to Expert P a systemic solution is required in order to solve problems like the pollution of the Atoyac river. She commented that within the next few days an International Association of urban development conformed by 12 people from different parts of the world, will come to Puebla. 'They work under the principle of solidarity and

have been successful. They will give us recommendations according to what has worked for them in the face of similar problems'. (Expert P, 2017)

Expert O participated in a project that involved a joint venture with other universities and government funds of the Energy Secretariat. They analyse the complexity of the Mexican energy system and intend to model the best decisions regarding energy sources in which Mexico must invest. 'In Guadalajara, the campus director encourages the introduction of sustainable projects inspired in the ONU´s objectives for the challenges in different courses and vertical workshops'. He commented that they work in a multidisciplinary way and that part of the success is the previous work of communication on the subject, 'we work with teachers and career directors so that they chose the challenge to collaborate'. (Expert O, 2017)

Expert B comments that her doctoral thesis was a great experiment on ESD. 'What I did was to focus on new educational tools and create a proposal based on pro-sustainable values.' She argues that these values are not included in the current educational system and that if we do not care to include the concept in the educational process, there will be no opportunity for young designers to include this theme in their professional practice. She also states that the way in which the current link is made with companies is not working because companies are focused on mass production. 'Companies are not interested in the intangible value of design for sustainability', she states. According to Expert B, the students finally assimilate the concept of SD and take it as something quite natural, but the process is long and difficult. (Expert B, 2017)

One of the sustainability oriented innovations in which Expert M has been involved has to do with the diffusion and culture of an ethno-botanical garden and educational centre to promote environmental culture. 'Through workshops, cultural activities and guided tours, we encourage citizen participation to engage in sustainability actions that can be done on a daily basis' says Expert M. (Expert M, 2017)

Expert J has participated in workshops involving presenting the possibilities and potential of projects to different local stakeholders. He proposes 'empowering people to solve problems of design'. (Expert J, 2017)

Expert F promotes 'global design jams', were people interested in service and customer experience (designers, students, academics, business people, etc.) meet

for a short period of time at locations all over the globe ‘in a spirit of experimentation, innovation, co-operation and friendly competition to develop and prototype new services inspired by a shared theme’. (Expert F, 2017)

Expert T states that he has not participated in sustainable-oriented innovations, but he proposes the use of materials efficient rated and designing products not to be replaced. He argues that manufacturing has a massive role to play, ‘it is only when new processes come about that in terms of design and sustainability, a real change is achieved’. He also states that there are some new materials and manufacturing techniques, the problem is that they are not on a mass manufacturing scale at the moment. Finally, he posits that ‘people will not buy products because they are sustainable, products still need to be good products and desirable products’. (Expert T, 2017)

Expert V proposes cooperatives to engage people as volunteers to work on local issues and make a difference. Through a cooperative she learned how to work with different stakeholders, how to track records, and how to continue getting investments. (Expert V, 2017)

According to Expert H, all innovations should be sustainability oriented. She posits that we are in a moment in time where designers have to think about what is the social, economic, and positive change they can do. She proposes to include this kind of thinking ‘truly integrated in the curricula’. (Expert H, 2017)

Expert S states that his first major project involved SD, it consisted of the use of recycle bio-isolates and inventing a system where this can be used. He did research about the creative use of bi-isolates and although he did not write an academic paper, he learned that the top soil is a fantastic resource and that in nature we can find a good inspiration for environmental, friendly and low cost solutions. Another project he worked on was about integrating sustainability in the design process, a lesson he learned is that designers must have the capacity to convince clients about the importance of the environment care, ‘the client must agree standards’. (Expert S, 2017)

G1.1.2 Results of the Community of Practice Seminar

Date: 02-August-2017

BCU Staff:	Six BCU's professors from the disciplines of Design, Architecture, Visual Communications and Law
PhD student:	One BCU's PhD international student
Mexican students:	Two students from the Summer School program at BCU

Ways in which sustainable development can be addressed in Mexico.

1. Students Evaluation
    - There is a need to design assessment to encourage students to take risks, learn from failure. If you do not fail, you will not learn certain issues. This kind of assessment is especially important in the first / second year.
    - One of the professors commented that they no longer assess their student´s project but the student's reflections, (the reflective process they followed).
    - Peer asses. This approach is the real life in the industry: People working together to make things happen. Generating a culture where students understand that when someone has a loss all the team lose / when someone wins, all the team wins.
    - It is important not to assess what the student do but his ability of learning to learn.

2. Learning Environment
    - Industry can work in an environment of risks easily. Industry can implement innovations faster than academia. Universities can participate by researching about the different types of risks.
    - Universities can push other types of learning. It is important to teach the students not to just do what the client wants (a narrow view), but to take into account social aspects, sustainable development, economical aspects, etc.
    - Less emphasis in the cost of things and more emphasis in reflecting / ethical considerations.
    - Promoting students to present the results of their projects to students at different levels so that everybody can benefit of the diversity of projects and decide what they want to do.
    - There is a "hidden curriculum": a class can be perceived as fun with one professor while perceived as difficult with another professor.

- Expecting no specific outcomes.
- Project based learning.
- Innovation is not only using technology but innovating in new ways of learning.

3. Understanding the complexity of the problem
    - Promoting critical thinking skills and a meaningful learning.
    - Importance of multidisciplinary approaches that considers marketing, policy making, etc. (Findeli) complexity.
    - Effective changes will come from the base (people) and not from the to (politics).
    - A need of a culture shift: promoting companies to understand the value of what students do. (This would help industry to also value what Universities do.)
    - Learning about other disciplines, learning how do other professions perceive the same problem. Promoting broader interpretations.
    - Academics empowering the students, getting them permission to do disruptive things.
    - When presenting results and projects to senators and politicians it is important to present not only the problem but the possible solution at the same time. Including artists, engineers, philosophers, etc. in the teams.
    - Presenting the problems and the solutions at the same time
    - Psychology– For example, what would have motivated the bus Union to change? …to participate.

4. Promoting commitment as a key for the future.
    - Promoting the visualization of the impact of projects before executing them.
    - The energy and inspiration should come from the professors. To achieve sustainable oriented initiatives, it is important to engage people, convincing them that a positive change can happen and that good results can be obtained.
    - Facilitate people acting as a group, embedding them together within an enterprise.
    - New generations in Mexico are starting to worry and they are willing to participate.
    - Sensitizing the students with real challenges, working in real communities.

- Mexico has different zones, different realities. Even though all campuses follow the same curriculum, there are different projects being developed according to the circumstances of each zone. This is a way of taking into account one of the results that the scoping stage has shown: that a sustainable development driver can be ethnicity, and diversity.
- Influencing not only students but all the stakeholders involved within sustainable development.

A comment from the inquirer: I do not expect to address all the issues that the scoping stage is showing. But to provide, trough the findings, new insights into the role of innovation in improving sustainable development education in Product Design, and to contribute to wider debates about combining innovative and traditional techniques, and multidisciplinary expertise and resources.

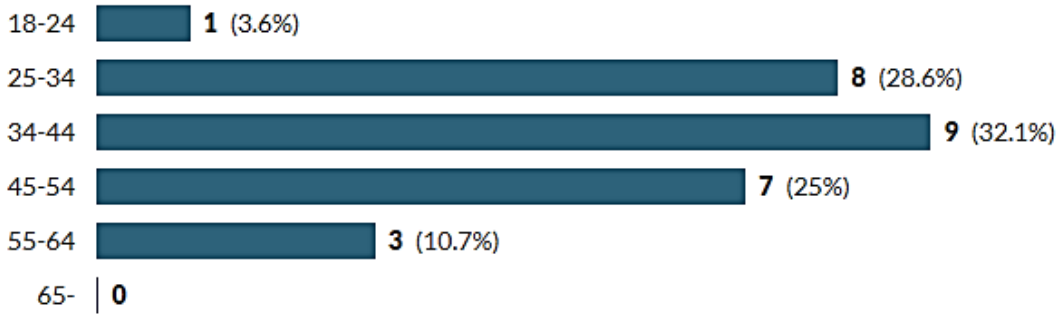
G1.1.3. Results of the Nationwide Questionnaire.

Focus	Existing pedagogical approaches to SD, in Product Design higher education, in Mexico.
Participants	Academics in 8 private Universities and 6 public Universities. A total of 31 participants answered the questionnaire
Date	November to December, 2017
Sections	Section I. Demographics. Section II. Inclusion of Sustainable Development in the curricula. Section III. The Educational Environment. Section IV. The curricula.

The following sections provide information on the demographics of the participants (section 1) in the nationwide questionnaire and the complete results from the questionnaire (section 2)

Section I. Demographics

1. Age



* Four participants did not answer this question.

2. Gender

* Four participants did not answer this question.

3. University

Private Universities	#Respondents
Tecnológico de Monterrey	7
Universidad Autónoma de Ciudad Juárez	3
Universidad Iberoamericana	3
UVM Puebla	1
Universidad Panamericana, Campus Guadalajara	1
UDEM Universidad de Monterrey	1
UDES Universidad de Ciencias y Desarrollo	1
CEDIM	1
	18

Public Universities

Universidad de Guadalajara	2
Universidad Autónoma Metropolitana	2
Universidad Anahuac	2
Universidad Autónoma de Querétaro	1
Universidad Autónoma de San Luis Potosí	1
Universidad Autónoma del Estado de México	1
	9

* Four people did not answer this question.

4. Position

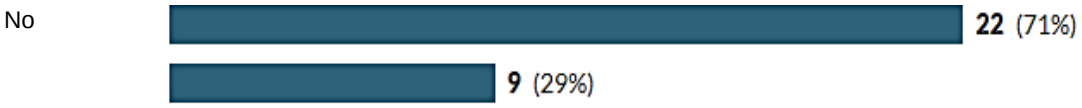
Regional Dean	1
Coordinator	8
Professor	8
Director of Industrial Design	4
Postgraduate Coordinator	1
Head of the Design and Innovation Academy	1
Researcher	1
Division Director	1
Ex-rector	1

* Five people did not answer this question.

Section II. Integration of sustainable development in the curriculum

5. Do you consider that the concept of sustainable development is integrated in the Product Design curriculum?

Yes



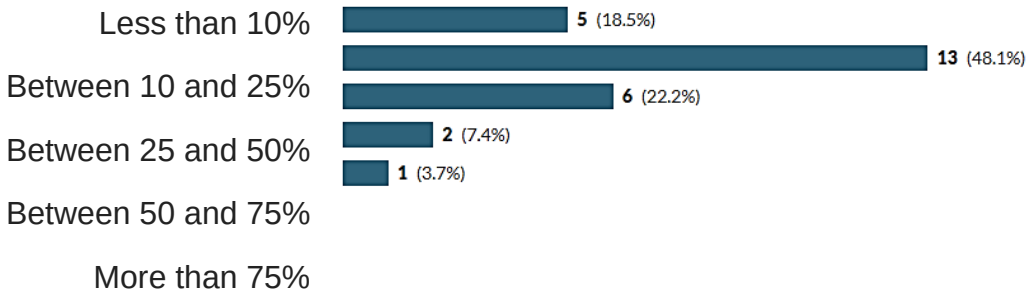
If yes… to what extent and in what ways do you consider sustainable development is integrated in the curricula?

- There are 2 subjects on the subject of sustainability, the classes of materials should be refocused for the analysis of sustainable topics and materials.
- Use of materials, community projects that promote social aspects
- It has presence from the commercial point of view (Design of sustainable business models) in matters of the last semesters, and from the environmental point of view in the first sector (although to a lesser extent).
- In addition to having a specific kind of sustainability, there are subjects that contribute to comprehensive training and concern the role of the designer in society.
- It is incorporated in theoretical and practical subjects.
- It is a subject in the curriculum and is called Sustainable Design Workshop, however, it is a subject that seeks the part of ecology and not completely what sustainable design seeks.
- There are at least two subjects, one related to the life cycle analysis of the product and the other is called eco-design.
- As subjects in Pre and postgraduate
- In developing products with ecological and sustainable materials such as wood, bamboo, reed, textiles, etc.
- It is part of the comprehensive academic training of a student of the UVM
- Currently I consider that it is included but in a very light way, the students take a subject called "natural sciences and sustainable development", and in two subjects of projects the study of the subject is also indicated, nevertheless I consider that the content with little relevance to the total number of subjects of the undergraduate. And although in some other subjects, teachers come to review the issue of sustainability, it is not mandatory to do so and each teacher focuses on the subjects according to their profile and point of view.
- In all the quarters of the Degree in Industrial Design
- Ecology subjects, in student profile
- In the specific development of projects that comply with sustainability requirements, regarding the manufacturing process and materials, as well as the recycling part.
- There are two ways in which it is incorporated, the first is in the curriculum plan approach, because being a Faculty of Habitat, there is a strong awareness on the subject, the second is the one that operates in the subjects, there are different subjects that go

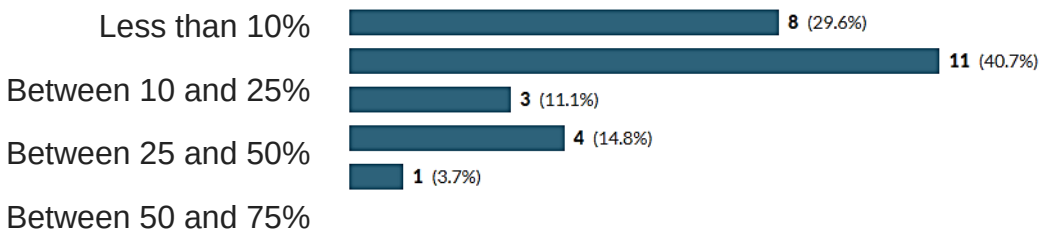
from the general to the particular in the profession from the knowledge of local resources, to design methods focused on social and environmental aspects. But difficult to say the measure, because it is a cross-cutting issue in the formation of students and will always depend on the responsibility of the teacher.

- With subjects in projects.
- Within the curriculum of the specialty in Design and Technology takes the subject "Sustainable Development", likewise, within the career are carried out some projects with that focus.
- It is induced, but not formally.
- Sustainability is one of the guiding principles of the Cuajimalpa Unit, and permeates the study plans of all its degrees through a UEA of the general trunk called the sustainability seminar. Likewise, at the level of the degree in Design, topics such as the analysis of life cycle in a transversal way in the laboratories are addressed. Towards the end of the training, the terminal laboratories have addressed issues related to research projects of department professors related to this area.
- It is included but not formally in the compulsory classes, it is found in an elective way and depending on the profile of the professor invited to teach these subjects.

6. What is the approximate percentage of topics that are related to the concept of sustainable development in the Product Design curriculum?

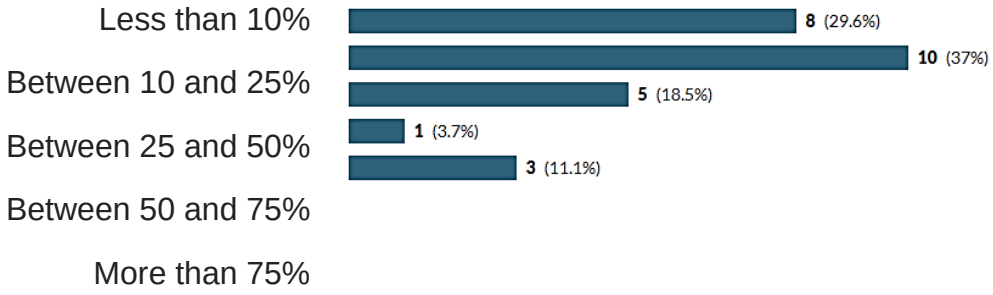


7. What is the approximate percentage of time within the curriculum that your Product Design Undergraduate's course dedicates to the issue of sustainable development?



More than 75%

8. What is the approximate percentage of time devoted to the issue of sustainable development within the parts of the curriculum you teach?



9. Do you consider that this topic is reviewed within the curriculum?

If it is… What degree of depth is involved in the review?

- In subjects such as Climate Change.
- As it is not compulsory or occurs in any subject for the curriculum, not all cycles are addressed but it is contemplated in the exercises
- It is one of several or many aspects
- Not enough, most of the subjects do not have a sustainability focus, they are only analyzed in the subjects that involve them.
- Direct application to industrial design
- I do not teach classes but I have seen that the teachers do not cover much on the subject of sustainable design, therefore a large part of the design community does not know the meaning of the word.
- It is evaluated to define the credits that will be assigned to the subject of sustainable design, for example, whenever there is revision of the curriculum, it is established if it is one or two subjects, or if it takes part in other subjects, for example in design for social innovation. However, the subject as such does not structure the curriculum.
- I teach 3 subjects in relation to the subject
- In the case of students at UVM, it is in the mission of our University
- I do not think that it is considered explicitly, only on some occasions but it depends on the teacher and his interest in the subject.
- It is reflected in the projects of our students

- Medium
- Not to the degree to which it should be working, it is starting to be considered but there is still a lot to work to do from the inside of the institutions to carry out tests.
- To a high degree, although the actions have not been the most strategic. I would like to point out that although the curriculum has a strong presence on the issue of sustainable development, it remains in the field of discourse, not of action.
- In the thematic contents of subjects and in the revision of the context
- Superficially
- At a basic level, since we are in a process of approaching the teaching staff to this topic and visualise how it can be integrated into the work in the classroom.
- Considerations for choosing materials and analysis of the possible life cycle in the case of product / service design

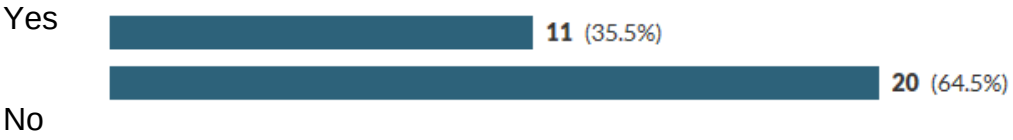
10. Do you consider that sustainable development teaching is having a positive impact on student learning and attitude?

If it is… Can you give an example of this?

- Projects linked to the community, with the use of local materials and habits
- Sustainable development teaching creates greater awareness and leads to reflection for the design and development of products.
- Everything goes in that direction, more and more.
- The reality is that it is not given the appropriate priority, from my point of view, and the subject could be better addressed.
- Students show great interest that design solutions are not only through objects.
- This concept opens the panorama of the role of design and sustainability.
- When the student understands that sustainable design is not only about the product being "green" but also economically accessible / viable and fulfilling an objective in society, then it is when they think better about their projects and design thinking systemically.
- It is difficult to answer this because its impact has not been quantified and it is not directly reflected in the advanced projects that are where I teach classes.
- Yes but students do not see it as a design opportunity but as an option or as an obligation.

- They are now more aware of what materials to use so as not to damage the ecology or the environment and to contribute to sustainable development of forest for instance.
- The students have subjects where not only theoretical examples are seen, activities are carried out where social relevance is discussed with this approach
- Yes, since there are more students concerned with the processes and waste of the products, however I am not sure if their concern is derived from the teaching in their curriculum or the general concern that exists of the subject.
- The projects they carry out are focused on solving social problems by applying sustainable development.
- The development of projects and study of sustainable development, generates a more responsible consumption of resources.
- Students are more considerate of what they do and are more interested in projects that have an impact on sustainable development, therefore incorporating the subject fully into the curriculum would emulate their learning and especially their work as professionals.
- They are told that within the design process that they should take this factor into account. Students are educated in the subject as part of their professional training.
- I believe that they are more sensitive to understand and be co-responsible to face the problems of scarce resources, inequity in the benefits of production and consumption, among other aspects.
- They are increasingly concerned with designing considering the environmental impact.
- It would have to modify the behavior and decisions of the designer.
- It is not found in the curriculum, it is more a general position, and the impact lies in the awareness when making design decisions.
- So far the greatest achievement is the awareness of being part of a system where resources are finite and all our actions generate an impact.
- Yes, I think they seek to generate options and alternatives to conventional materials, or question about processes involved in manufacturing, etc. However, I believe that it continues to be perceived as an "extra" or added value, not as an implicit characteristic in the design of the product.
- The teaching of sustainable development and sustainable practices as part of the design process are shaping the way to address the challenges, students who have had this experience tend to use sustainability as one of the variables to consider especially at the time of the election of materials.

11. Are there any specific ways in which your University measures the effectiveness of teaching and learning in relation to sustainable development?



If yes… What are the ways and how do they work, for example, who is involved and how often does it happen?

- Projects linked and reviewed with some audits, for instance, those offered by programmes such as ECOTEC and CES EduPack.
- Projects are evaluated at each end of the cycle, synodals and students intervene.
- It is an indicator for accreditation and is part of our vision and mission. There are sustainability reports.
- Only on undergraduates that have a direct impact on issues related to sustainable development.
- Only with the indicators of grades per semester.
- Conferences are held on the subject and there are exhibitions of related projects in the “UVM day”.

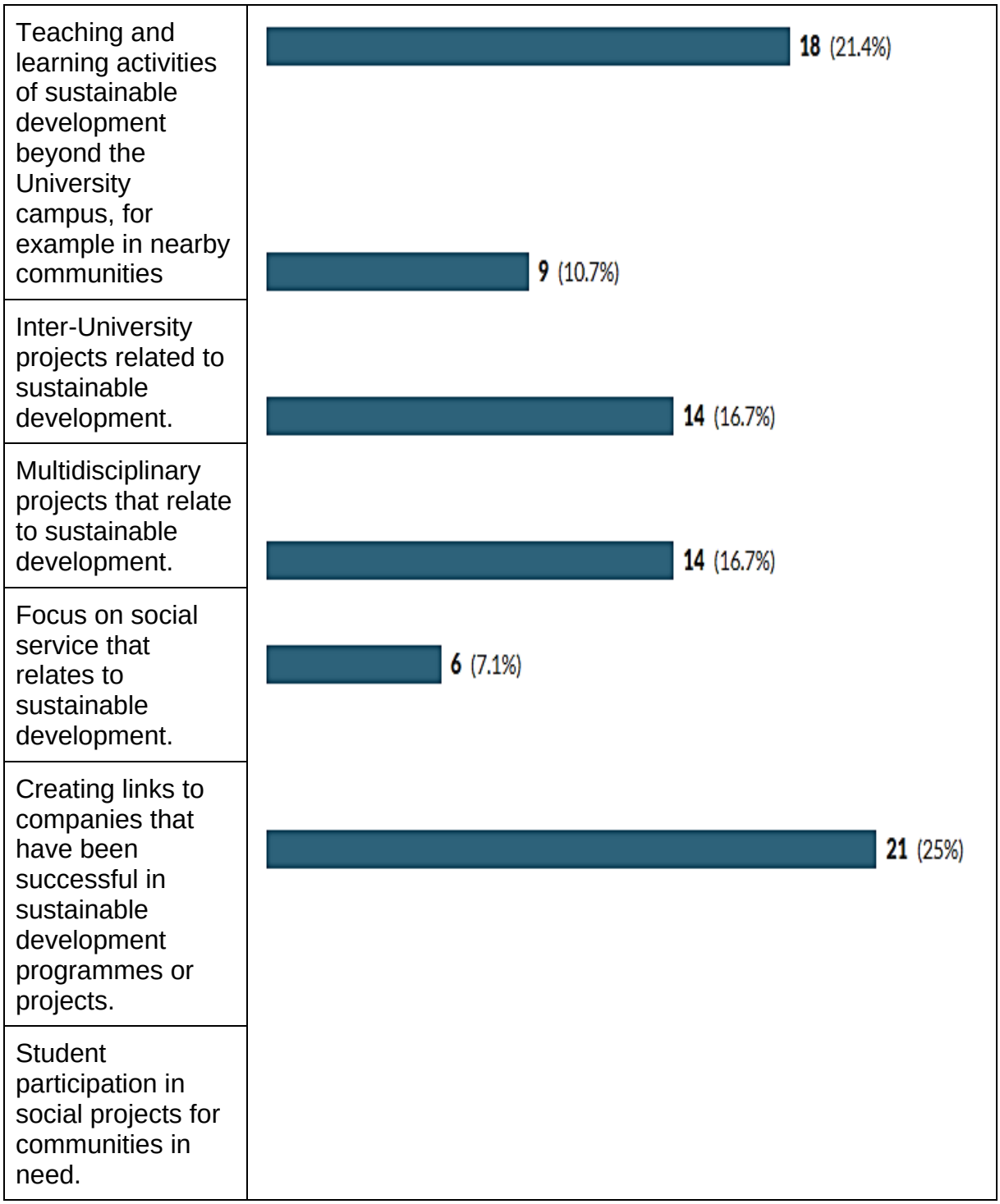
12. To what extent is your Product Design Undergraduate's course aligned to sustainable development agendas, such as those promoted by organisations (for example, companies, government, global networks

- All projects go through the audits of ECOTEC and CES EduPack programmes.
- There is no alignment unless a specific project for sustainability purposes is created.
- Sometimes they do, but it is not enough.
- Few subjects integrate them, and we do not take into account environmental factors.
- It is considered as an important line, however not all subjects include that issue and many times it depends more on the teachers.
- The undergraduate is linked with companies, public institutions in initiatives.
- None of my classes.
- Definitely not aligned by what companies promote, and the role of government is not always relevant. In my case I think that the subject is approached from different ideas about sustainable design, for example the affective links that exist between a product and a person and thus avoid the anticipated disposal.
- The concepts are taught but there is no relationship with external organisms.
- I support the practices of a responsible use of forests and wood, I promote that students only buy in places that have government certification like SEMARNAT.

- UVM is involved with these projects from the state and municipal government proposals addressing the problem as an affected community.
- They are not.
- To the extent that there is collaboration with any of the entities mentioned.
- They are not.
- Little, but they are taken as a basis to develop projects that include sustainable development and thus generate students who are more aware of how they develop and produce better products.
- Not so far, it is scheduled for the near future and a link is being sought.
- To the extent that we know these agendas, but are not the main guide to raise the development of the subject.
- They are not aligned completely.
- No.
- Little, only in the case of some specific projects.
- In particular, I include social sustainability, specifically inclusion, but it is not something that is officially demanded.
- Still not participating in a timely manner.
- We are at the level of contributing to the institutional agenda (Unit), which has tried to focus on everyday actions that promote environmental protection and social inclusion. Also, through initiatives stemming from participation in research networks, such as the Lens project.
- Certain topics or examples are covered, but it is not directly related to any specific proposal or organisation.
- Virtually nothing, there is a very superficial knowledge of the subject and / or relapses into just a few.
- They are not aligned with sustainable development agendas, as I said earlier it is more an effort pushed by the interests of teachers at the forefront of the subjects taught.

Section III. The Educational Environment.

13. Which of the following sustainable development oriented activities are promoted in your University?



14. Do you consider that technology can be an efficient way to promote sustainable development education?

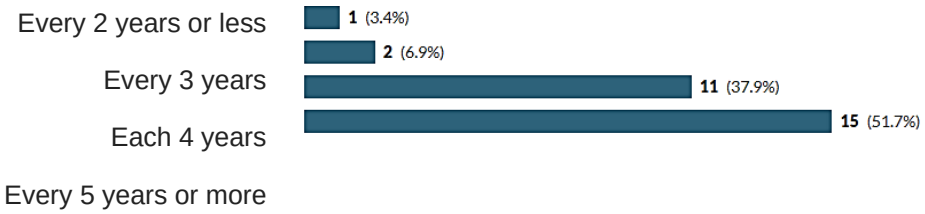
If yes, to what extent do you consider that technology can be an efficient way to promote sustainable development education?

- “Semana i” and “semestre i”. Project “Tierra de artistas”. Projects with 3M. “Casa de las parteras” in Chiapas.
- Currently, everything is related to technology, so at this moment not using it would be very slow to develop projects.
- Reducing waste, time, transportation, etc.
- The ability to move information makes it easier to spread the concepts related to the topic.
- In conjunction with the human development career for sustainability, different projects have been developed in the communities.
- Using platforms with information that serve as support for students where they have access to information necessary for academic and professional development that may or may not be part of the study topics, ie, that there is also information or courses that children may have to learn topics that are not taken in the classroom.
- A long-term issue requires simulators that help answer unknowns about a prospective topic.
- A specific case may be digital platforms that can promote particular tools, videos, presentations from other places, etc.
- To make more graphic design education
- For example to bring online education to remote communities
- The simple fact of being able to see similar cases in different parts of the world using the multiple means of communication and being able to see the results achieved
- It is a double-edged sword, I think that if you know how to use it can be very beneficial, however in the technological advance it is very common to have technologies or objects that become obsolete very soon.
- They are only tools for students that allow the solution of problems more easily
- Local manufacturing
- I think it can help generate simulations, virtual tests and better communication for the development of sustainable development projects
- In the undergraduate is essential to use management and knowledge of technology to apply at different levels of solution

- It would be the case of visualizing, numbers, quantities, when simulating cases where the lifetime of a product is measured, or in general the eco-indicators. They help to complement the information, but they will never substitute the knowledge in the field, it impacts more when young people know the people in their environment and the consequences they suffer because of the irrational use of resources by large industries.
- Through social networks
- Using databases and images of successful projects as success stories
- The correct use of technology can promote education for development
- Through simulations, links at a distance, approach to other realities, etc.
- The use of technologies, whether traditional or new, facilitate the educational process and therefore the development
- Participation of the students in laboratories, terminal projects and social service in activities derived from or linked to research projects of teachers and their participation in networks. For example, in the project of web platform for learning focused on the sustainable design of the LeNS network (Learning Network on Sustainability), the research projects "Design of habitats for pollinating species under climatic, productive and social conditions" and "the haptic design and its importance in the generation of editorial materials for people with visual disabilities".
- Yes, with the dissemination of information and self-learning, especially in the youngest.
- Because of the impact and diffusion that may have.
- Technology makes it possible for knowledge to reach more people and spread more quickly, in addition to connecting people, an example would be connecting students with people from needy communities and working some parts of the design process remotely.

Section IV. The curriculum.

15. How often does your University update the curriculum?



16. What are the key factors or principles that guide the updating of the curriculum in your University? For example, relating to professional / industry / subject-specific contexts or challenges; social / political agendas, employability, internationalisation contexts or challenges.

- Learning based on Challenges, to acquire competencies. Human sense, Internationalisation and entrepreneurship.
- Mainly the labor demand and what is happening in the context as well as the needs of our environment and the industrial sector
- I dont know
- The megatrends, the industrial / commercial / creative activities of the environment and the world.
- In addition to the University's own policies, feedback from graduates and employers is very important.
- Advisory council, labor demand, international challenges, community needs
- Employability, demand and trends in companies.
- Mainly the competitiveness in national and international.
- A very important factor is the context, because it defines the relevance of the discipline. Another factor that is also present are the general tendencies of the design, a very strong one is the sustainable design, nevertheless, it is not the subject that structures our curriculum. I think that, if there is a slow change, that it is related to the subject in question, and is to design for people instead of just justifying the design of objects by the needs of the market, which requires unlimited consumption to maintain itself.
- The evolution of design in the region
- According to social and humanistic contexts
- In the first place, the locality or ecosystem where the community is located, affected by its social, cultural, economic and political aspects, later the tendencies of the global network are reviewed
- I think that at the moment it is to generate students that get involved in real projects from the University so that when they leave they have a wide experience in facing challenges of diverse types (social, industrial, technological, etc.)
- All mentioned

- Professional challenges, human formation, employability
- The needs of the market and the new skills that a new graduate should have in future years. They will not always be skills that are easy to describe.
- Internationalisation, social aspects and industry
- What guides the updating of the curriculum is the tension that is generated between the epistemological principles on which the Faculty generates knowledge about the habitat and what the market demands as a profession for economic development, where despite talking about the social and environmental benefit, the technical-commercial is the one that prevails, hence the Faculty, especially in careers such as industrial design, seeks to maintain a space for criticism and generation of knowledge.
- Local context, meetings with graduates, employers, students who have participated in mobility or academic stays, adaptability with the global definition of industrial design, internationalisation.
- fashion in design themes
- Contact with employers and companies in the region, agenda 21 of the United Nations.
- Accreditations and labor challenges
- Effects of technological development, and market adaptation, as well as public policies.
- The updating of the Plan of Studies responds to different factors, on the one hand the relevance of the theoretical foundations in relation to the challenges of the discipline in the social, environmental, economic context; the technical-productive qualification according to the professional field and employment within the national context.
- Relationship with programmes at the national level, inclusion of social service in topics related to context, linking projects
- Needs of the Industry, labor market, local needs.
- The updating of the curriculum is guided by the demand of both the labor market and the final consumer. It is important that the curriculum is not only updated with the present needs but that it is avant-garde in the sense of taking into account the needs to which the graduate must respond to future. Therefore, before designing the plan, it is necessary to carry out a foresight exercise where we can perceive the social, cultural, economic and technological factors that will impact the context of the future graduates.

G1.1.4. Results of the methods applied at TEC (1st).

The Interviews.

Ten professors were interviewed for the first methods applied at TEC in the South Region of Tecnologico de Monterrey, including the Puebla and the Toluca campuses. Participants A, B and C have a management role at the University, in addition to teaching at the School of Architecture, Art and Design. Three interviewed professors are full time professors (Participants D, E and F). And four are part-time professors: (participants G, H, I, and J). Sixteen current industrial design students were interviewed for the first methods applied at TEC. Ten of the students belong to Puebla´s campus and six to Toluca´s campus. Three graduates from the Industrial Design Undergraduate at the Puebla´s campus were interviewed,

One selected unit of analysis for the first methods applied at TEC was *multidisciplinarity*, an important variable that was identified through the scoping stages. Other important units of analysis that were considered are: The *integratedness of sustainable development in the curricula* and the *measurement of the effectiveness of teaching and learning in relation to sustainable development*.

The findings from the interviews are the following:

- The social aspect of SD is not the first aspect that comes to the student's mind, the inquirer had to give them a clue. This can be a valuable feedback to the curricula: the pedagogy needs to change in order to change the predominant way of thinking. Through the Research the concept of what sustainability is and what it encompasses could be broadened. Both graduates and current students of industrial design mainly relate SD with green design and ecology. It is not clear for them that SD also implies social design, design of products and services related to supporting communities and populations in situations of disadvantage. A key finding therefore is that pedagogy should change to achieve a change in the predominant way of thinking.

- The results and reflections are quite consistent between the Toluca´s students and the Puebla´s students.
- Both graduates and current students agree that more activities, projects and subjects are needed in their classes related to SD. One Toluca's students commented: 'these subjects must be learned much earlier in the undergraduate, we are learning it now that we are in the eighth semester, it should have been learned at the beginning of the undergraduate'.
- Both groups also agree that there is a need for more opportunities to work in multidisciplinary environments related to SD, and that these should take place in advanced semesters of the undergraduate where they can make more contributions as industrial designers.
- Toluca´s and Puebla´s students mentioned only one or two professors as well as one or two classes that are linked to SD projects, and activities.
- The subjects that the students of Puebla mention (related to SD) are different from those mentioned by the Toluca students. It seems that this is more related to the professor´s way of thinking about the discipline of industrial design.
- In the School of Architecture, Art and Design, in the South region of the Tecnologico de Monterrey, projects related to social impact and SD are mainly linked with the architecture undergraduate than with the industrial design undergraduate, (they are more in quantity, with greater impact, more organised, with more students and teachers involved, with more diversity in terms of ways to participate: linked to classes, as a social service, such as semana i, semester i, etc.)
- There are professors taking classes, which are mainly technical, and they are not currently including SD in their classes because the syllabus of the class does not explicitly consider this subject. If, as my study argues, SD should be integral across all subjects within the curriculum, a key finding is that there is an opportunity to redesign the curriculum so that SD is taken into account in these technical classes. The interviews

indicate that the professors are open to integrating this subject into their classes.

- All the interviewed professors and Deans in Puebla and Toluca said that currently there are no tools for measuring the effectiveness of teaching and learning in relation to SD.

After reviewing the results of the first application of methods at TEC, some adjustments were made to the design of the methods applied at TEC. One open question at the beginning of the interviews was added: What do you know about sustainability? The inquirer explained to the participants that there are no right answers, so that they feel free to express their opinions.

The Walking Interviews Methodology (first application**)**

The walking interviews methodology was described in the Research Methodology chapter. Firstly, photographs of different interior and exterior spaces were taken at the Puebla and the Toluca campus, as part of the methods applied at TEC, and a table with the most relevant information was filled out. This table was divided into two sections: one at the level of denotation or reportage, which includes each photograph and a brief report about it and another section at the level of connotation, which includes the meaning, implication, suggestion, undertone and inference of each photograph.

The connotation section of the table, which was prepared for this Research, contains the answers of the following questions: What does the photograph communicate about the curriculum? What does the photograph communicate about EDS? What does the photograph communicate that the interview was unable to suggest? In this way, the information collected from the interviews was complemented and contrasted with the notes, observations and photographs in this table.

Results of the application of this methodology for the first application of methods at the Puebla campus are as follows. Note: the tables that contain the

photographs and the detailed information on the level of denotation and connotation for each picture can be reviewed in the corresponding Appendix.

- Photographs presenting SD being taken into account in the curricula. For example, one documents a prototype of a habitable emergency module for people affected by the earthquake in Mexico, in 2017. It was designed and constructed by students of the “semana i” project. The photograph records the work of a student who had worried about creating solutions for people in need who were affected by the earthquake. However, the image could also be viewed as showing how the student who had led that project had not yet found the opportunity to donate the unit for its intended use, as it was still on the campus (connotation level).
- Another photograph records green areas of the campus where plants of the region that consume less water have been planted, instead of planting grass. While this image may communicate a positive manifestation of a SD effort by University, there are other photographs, showing many other green areas on the campus, where these plants have not been planted.
- Photographs, which record, the absence of containers near to printing machines for recycling paper inside offices. The waste bins inside the offices are the traditional ones, there are no special bins for recycling paper. Another photograph records a container that attracted my attention because, even though its purpose is to enable the separation of different materials, it does not have any signs informing the user about which kinds of materials should be placed in which of the container's openings / portals. Connotation level: ESD is not only relevant to the curriculum but can also be relevant to the day-by-day culture of the University environment. The University can do more to promote EDS, as something is still missing in the promotion of a SD culture.
- Photographs documenting parking lots full of cars and almost empty bicycle racks on campus, as the majority of the students go to the

University by car. In the interviews nobody has mentioned the need for reducing the use of cars and increasing the use of bikes. Connotation level: In Mexico we do not have the culture for using bikes. There is still much to do in the promotion of SD. We have not done enough to sensitise the students toward SD thinking.

- One photograph shows a positive initiative of Tec the Monterrey, in favour of sustainability: Students, employees and teachers can bring their own thermos and fill them with water here, so as not to buy plastic bottles that then contaminate. Connotation level: The University is making some efforts in the promotion of SD. In the interviews to students and professors that have been conducted, they have not mentioned this initiative.
- Another photograph was taken inside the building # 4, where the Industrial Design students take the majority of their classes. It shows an initiative that seeks to collect and recycle plastic caps to support children with cancer from an orphanage. Connotation level: Not only through the curriculum the SD culture can be promoted, but also through complementary initiatives like this, that can reinforce the SD culture. In the interviews conducted, nobody mentioned this initiative.
- A photograph shows a lamp made out of recycled plastic bottles. It corresponds to an exercise carried out in my Experiences Design class, which belongs to the fifth semester of the Industrial Design Undergraduate's. Connotation level: there are subjects in the curriculum where the students learn to recycle materials and to create products with them. There are professors concerned with this issue.

Results of the first application of methods at TEC at the Toluca campus are as follows:

- Some photographs show rubbish containers in the campus, not all of them are properly labeled to indicate the different types of waste. This time, some participants were invited to participate, one of them mentioned that the campus produces a ton of daily trash.

- One photograph captured a sign next to the main entrance of the Toluca´s campus: "Campus free of tobacco smoke". This is another way in which the University is promoting a SD culture.
- A photograph shows a wooden platform in which recycled pet bottles were fixed to make a green wall with plants from the region. It could communicate that the students are being encouraged to recycle materials and that there are subjects in the curriculum where the students learn to recycle materials and to create products with them. It could also communicate that there is at least one professor concerned about promoting a sustainable culture.
- Some photographs show a small house within the campus, it is an “Ecological House” which is built of tires, glass bottles and ceramic floor pieces. It could communicate that students are being encouraged to recycle materials and that there are subjects in the curriculum where the students learn to recycle materials and to create products with them, as well as professors concerned about promoting a sustainable culture.
- During the walking interviews procedure it was observed that in this campus many students use bicycles and that there is good signaling to favour its use. It was also observed that the bicycle racks at different points of the campus are in use. This could communicate that this campus is promoting a culture of sustainability, not only through the curriculum but also in a practical way, SD is something that can be taught not only in a theoretical way. There are still more students who use the car instead of the bicycle, but this smaller campus sets the example for Puebla, which is the headquarter of the southern zone and lacks this type of signaling.
- The campus is full of vegetation that makes it very pleasant to walk in it. The campus is 36 years old, therefore it has many tall trees. (The Puebla campus is only 15 years old). The parking lot is a very pleasant area, there are many pines and trees that shade the cars and that embellish the landscape. This was observed during the walking

interviews methodology, it is something that the interviews to students, graduates and professors were unable to suggest.

- Some photographs show areas inside the Toluca´s campus where plants from the region, which consume little water, can be appreciated. In general, the campus is full of vegetation everywhere, this creates a very beautiful and pleasant environment to walk and to sit at. This is another example that confirms the usefulness of the walking interviews methodology, as a complementary method: it permits the inquirer to experience the culture and context of the place that is being studied.
- One photograph shows a poster on a stand where some students were promoting the collection of toys to donate to children of limited resources. This could communicate that SD is being promoted not only through the curriculum but also in different activities that involve the active participation of the students. It also could communicate that there are opportunities for students to get engaged with SD activities and that some of them are willing to participate and promote SD. It also shows that the University supports a culture of a social SD not only in the curriculum but in practical ways. In the interviews with students that were conducted, they didn't mention these activities, but they were observed during the walking interviews procedure.
- Two photographs show a recent initiative of the Toluca campus: they have an area where they care for abandoned dogs, the dogs are fed here and prepared to be adopted by students. This photograph could communicate that the campus is concerned with teaching not only theoretically and directly through the curriculum but also through indirect means and through teaching by example, promoting initiatives like this one. In the conducted interviews with students, graduates and professors nobody has mentioned this interesting initiative.
- A group of photographs were taken next to the Architecture and Industrial Design building. A habitable module for disaster situations that students designed and constructed was observed. This could communicate that there are professors and subjects that take into

account the SD issue. Good initiatives like this one, reinforce the SD culture. In the conducted interviews with students, graduates and professors nobody has mentioned this interesting initiative.

G1.1.5. Results of the Methods applied at TEC (2nd).

The findings from the interviews in the Guadalajara and the Monterrey campus are the following:

- As mentioned before, a new question was added to the interview to ask the participants their opinion on what for them constituted SD. Only two professors and one student (out of the 31 participants) mentioned the social aspect of SD. This is consistent with the previous results found in the first application of methods at TEC, the majority of the persons link it with the ecological aspect only.
- Very few students were able to mention projects and activities that they have carried out at Tecnologico de Monterrey in relation to SD. The majority of them mentioned only one subject, what is more, one of the students stated that there is one professor that does offer a sustainability focus, but it is clear that it is because of her personal initiative and not because of the curriculum. One of the students that mentioned that she has not reviewed this topic in any of her classes, also stated that several of the materials for prototypes that the students learn to use in the undergraduate are toxic.
- In one of the interviewed groups of students, as there were not enough examples of activities and projects related to SD that the students could mention, I had to remind them that SD also implies projects with a social impact on the community and / or disadvantaged populations, not just green design or ecology. As a result, one of them stated: 'I hardly learned the subject in my classes, the teachers do not encourage us to develop sustainable projects, it is almost always only at the initiative of the students themselves'.

- When asked if they considered that the topics, activities and projects related to SD are effective and / or sufficient; 100% of the students said that they are definitely not enough and that there should be more activities, projects and contents. In this regard, one of the students expressed: ‘There is a need of commitment in the area of Design at national level as currently it is not something that goes through our heads. Biotechnology students know about the subject and we designers also have the capacity to develop competencies towards environmental design. It is a niche of opportunity’.
- 100% of the students also agreed that there is a need for more opportunities to work in multidisciplinary environments related to SD, where they can make more contributions as industrial designers. In this regard, one of the students commented: ‘There should be more, industrial design is very isolated from other careers. We do not have enough subjects with engineering students, only at the beginning of the undergraduate we attend subjects with students of architecture and arts. But to reach deeper solutions we need to work with students from careers that are more different from ours’. Another student added: ‘I think we should have more multidisciplinary experiences and not only with the closest ones (architecture, art). Business students can give us another perspective and points of view that help us develop solutions that we alone cannot achieve. It is a way to get new knowledge and learn more’.
- All the interviewed professors from the Monterrey and the Guadalajara campus stated that currently there are no tools for measuring the effectiveness of teaching and learning in relation to SD.
- In general, the professors showed concern about the lack of enough content on SD in the written curricula. One of them stated: ‘Greater emphasis must be placed on the culture of SD. I think that one subject is not enough to have a good idea of the landscape and the responsibility that we face as designers. We must further deepen on ecological issues, we must know the impact on the environment and we

must learn more about the use of renewable resources and how to return to the environment what we exploit'.

- When asked about the benefits for the students of the activities and experiences related to SD, the professor that was mentioned the most in relation to the subject, said: 'They get wide conscience of the urgent need of changing the way we produce and consume products and services and begin to understand the importance of doing research in other to get a product that not only attend the human needs but also that changes bad habits that are killing our planet. They also get to understand the powerful influences that designers have upon society and that is also a responsibility for designers to contribute in a sustainable way in the making of the design process'.

G1.1.5. The Walking Interviews Methodology

In this appendix, the results of the application of the walking interviews methodology in the Guadalajara and the Monterrey campus are presented. As exposed before, this time, some professors were invited to participate in the process, this was one of the main adjustments that resulted after applying the methods at TEC in the Puebla and the Toluca campus.

For the Guadalajara campus application, three Architecture professors participated giving their opinion on the sustainability culture that they live day to day at the campus. The results are as follows, and the tables that contain the photographs and the detailed information on the level of denotation or reportage as well as the level of connotation (meaning, implication, suggestion, undertone, inference) can be reviewed in the corresponding Appendix.

- One of the interviewees mentioned that there is a service in which you can borrow a bike but is for the use inside the campus only. Some of the photographs show bicycle racks that are in use, signals for cyclists and a maintenance module where students can go to repair or adjust their bikes by themselves. The photographs could communicate that there is congruence between what is taught to students regarding SD and the practices of the University.
- Some photographs show rubbish bins that are not properly labeled to clearly indicate to the users which type of waste goes on each container. The same happens in Puebla and Toluca, there are rubbish bins that are not properly marked. This could communicate that there is much to do yet to reinforce what is taught and the practices of the University.
- A photograph shows a signal that promotes the philosophy of “A place for everything and everything in its place” in relation to the separation of different types of waste. This could communicate that the students are being encouraged to recycle materials.

- Some photographs show areas in the campus that are full of trees and vegetation, there are also hammocks under the trees. This could communicate that the campus gives importance to offer the students comfortable zones to rest and study. One of the participants (a professor) mentioned that there are areas on the campus where there is artificial grass. And she also explained to me (with disappointment), that the dye that pollutes the most is the green one.
- One photograph shows a signal about an initiative that has been launched in all the campuses of Tecnologico de Monterrey: "Campus free of tobacco smoke". One of the participants stated that there are five zones inside the campus where people can go for smoking, but the “Campus free of tobacco smoke” initiative is supposed to offer no zone for smoking. There is a contradiction on this campus.
- There is one photograph that shows an area of grass that is being watered with recycled water. This could communicate that the SD is being promoted at the University.
- One photograph shows the Innovative Entrepreneurship building. It is important to mention that one of the architecture professors mentioned that this building consumes 10% of the total energy of the campus, since it was designed in such a way that the main façade faces south-east, ‘a bad decision of the person who designed it’.
- One photograph shows the library, built in 2013. One of the architecture professors stated with deception that five great trees were eliminated in order to build the library. The picture could communicate that there is still much to do in order to be congruent with ESD. The same participant also mentioned that in his opinion (as an architect), it was a wrong decision to have a glass façade for the library, as the building consumes great quantities of air conditioner. According to him, the academic architecture department was not invited to participate in the decisions for the building design.
- A photograph shows the “Engineering, Architecture and Design Ecosystem” building that was inaugurated in March 2017. One of the

participants mentioned that by chance she had the opportunity to see the original architectural plans and she was surprised to see that the north elevation of the building didn't considered windows, even though that is the most favourable elevation for windows, again, the academic architecture department was not invited to participate in the decisions for the building design.

- One photograph shows a water purifier and dispenser that promotes the use of personal (not disposable) bottles instead of PET bottles. This could communicate that the campus is concerned about promoting a culture of SD.
- One photograph shows a sign that says that 99% of the energy that the campus uses is “clean energy”. One of the professors who participated in the walking interviews process explained that the reality is that the campus pays for energy from wind and solar plants that are based in Oaxaca, where it is common for very poor people to be displaced from their land to establish these plants.
- One photograph was taken inside the toilets. It shows a hand towel dispenser with a sign that suggests the user to take only one towel to reduce waste. It could communicate that the University is promoting good initiatives like this one, to reinforce the SD culture.
- One photograph shows a small wall on the balcony of one of the buildings inside the Guadalajara campus. One of the participants explained that the way that materials were applied is not efficient: Rough materials should not be used in these areas because they get dirty quickly and this causes the material to look bad and last less.

For the Monterrey campus application, one Industrial design professor and one Math professor participated giving their opinion on the sustainability culture that they live day to day at the campus. The results are as follows, and the tables that contain the photographs and the detailed information on the level of denotation and connotation can be reviewed in the corresponding Appendix.

- One of the photographs shows rubbish bins for separating different types of waste. The Monterrey campus has initiatives that promote a SD culture. It is important to be congruent between what is taught to students regarding SD and the practices and environment at the University.
- Some photographs show signals for cyclists and bicycle racks that were not there one year ago. The University is promoting the use of bicycles in all of the campus, it is a new initiative. The picture also confirms the usefulness of the walking interviews methodology, as the students did not mention this in the interviews, it is important to live the culture and environment of the campus, as a complement for the survey´s results.
- Some pictures show initiatives that in different ways are linked to a SD culture: One picture shows a signal that reminds the students that this is a campus “free of tobacco smog”. Some photographs show Mexican native plants in different gardens of the campus. These plants have the characteristic that their water consumption is minimal in comparison with gross. One picture also shows an exterior area that was covered with small stones combining different colours. The native plants are a better solution as they can generate oxygen. In general, the campus offers different nice spaces for the students.
- One photograph shows a water purifier and dispenser that promotes the use of personal (not disposable) bottles instead of PET bottles. Another one was taken inside a professors' offices area and it shows that the professors are promoting the recycling of various types of bottle caps.
- Regarding the constructions inside the campus, two photographs show the Building #2 and Building #4, where fixed parasols can be seen on one the west and the east elevations. The climate of Monterrey is extreme: in summer it reaches 45 ° centigrade. The west facade of the buildings is the most affected by the sun. One picture also shows one of the entrances to the student´s dorms and it shows several windows that

were oriented to the north in order to avoid the direct sun´s light of the west façade.

- The previous ones are good examples of sustainability, but there are also examples of the opposite: some photographs show the new library building and its electrical escalators. The professor who accompanied the inquirer in the walking interviews process stated that each time that it rains the escalators must be covered by a big plastic to avoid damages in the mechanism. It was not a good idea to put them in an exterior area. Another picture shows the “Cedes” Building (“Centre for SD studies”) that was built around 1992. One architecture professor stated that this building consumes great quantities of the total energy of the campus, (in air conditioner) since all the façades are covered by glass, even though the Monterrey's weather is not suitable for this design. In addition, there are walls and escalators that were painted in green (even though the most polluting dye is the green one).
- One photograph shows the programme of a Conference was undertaken at the moment of the walking interviews Methodology. It is written there that the disposable plates and cups can be recycled (made of cardboard). In recent years, many professors have complained about the excessive use of polystyrene plates and cups inside the University. This is a good example of an initiative that was recently implemented to generate an impact on having a more sustainable campus.

G1.1.5.1 Summary of The Walking Interviews Methodology Tables

This participatory and observational method of interviews belongs to ‘cultural mapping’; a systematic method of collecting information on ‘people’s historical and contemporary relationships with local environments’ and collecting ‘social, historical and ecological data in situ’ (Strang, 2010).

The researcher photographically recorded different interior and exterior aspects of Tec de Monterrey’s Puebla, Toluca, Guadalajara and Monterrey campuses. The following tables present a representative range of examples of the application. The original exercise included 20 photographs taken at the Puebla campus, 30 photographs taken at the Toluca campus, 29 photographs taken at the Guadalajara campus and 30 photographs taken at the Monterrey campus. In this Appendix, a selection of 6 representative photographs per campus are presented as a summary of the exercise. The layout of the information below, follows the way the method was used by the researcher. That is, the subject of the photograph is reported on in a factual way and then the reporter offers interpretations the images, in the context of education for sustainable development.

The researcher used the following questions in relation to the interpretations: What does the photograph communicate about the curriculum? What does the photograph communicate about sustainable development education? What does the photograph communicate that the interview* was unable to suggest? *Interviews to professors, graduates and professors were applied as part of the information collection methods applied at TEC in the Scoping exercise (Cycle 1).

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Puebla Campus.

The researcher's photograph (13.02.2018), report and interpretation

Subject	Annotation
	This is a picture of a lecture for Architecture students. The title was "Biking in Holland, it is all about infrastructure". The lecturer was Maikel Waterdrinker, an architect from Holland who lives in Mexico. He talked about the great culture of using bikes instead of cars in Holland (that contrasts with our culture).

Interpretation

The image communicates that the sustainable development issue is promoted not only through the curriculum but also in different activities with guests from outside. The classroom was full of architecture students, there was only one industrial design student. (both bachelors were invited, but the majority of the interested students were architects).

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Puebla Campus.

The researcher's photograph (13.02.2018), report and interpretation

Subject	Annotation
	Near to the printers there are no containers for recycling paper. The rubbish bins inside all offices are like the one in this picture (that does not permit the separation of materials).

Interpretation

The image communicates that something is still missing in the promotion of a sustainable development culture. That sustainable development education is not only an issue that should be promoted through the curriculum but also in the day by day culture. That the University can do more to promote sustainable development education.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Puebla Campus.

The researcher's photograph (13.02.2018), report and interpretation

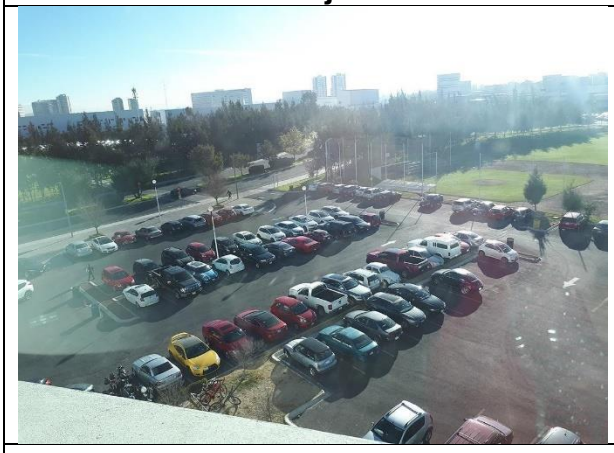
Subject	Annotation
	This container got my attention because even though it is supposed to separate different materials, it does not have any sign indicating which kind of material goes in which hole.

Interpretation

The image communicates that Tec de Monterrey has this initiative to promote sustainable development. But there is still much to do, this in an example, we must take care of the details when recycling, to really give the image we want to the students. There are several containers like this inside the campus, which does not have adequate signage.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Puebla Campus.

The researcher's photograph (13.02.2018), report and interpretation

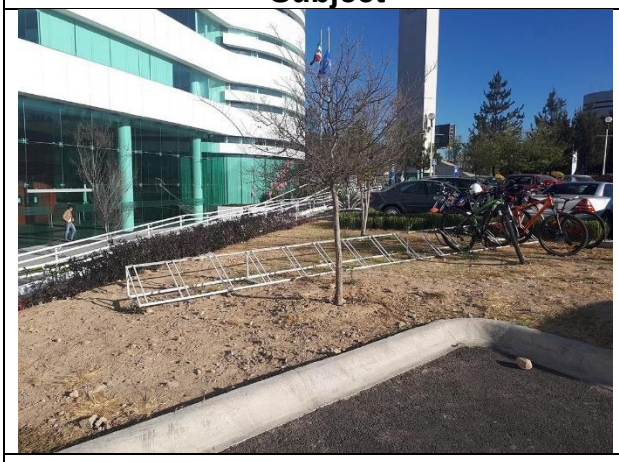
Subject	Annotation
	The majority of the students go to Tec by car. In Mexico we do not have the culture for using bikes. This is the parking lot at the Building #4, were the majority of the Industrial Design classes are held.

Interpretation

The image communicates that it is not enough what we have done to sensitize the students in the need of a sustainable development thinking. In the interviews nobody has mentioned the need for reducing the use of cars and increasing the use of bikes. There is still much to do in the promotion of sustainable development in the students.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Puebla Campus.

The researcher's photograph (13.02.2018), report and interpretation

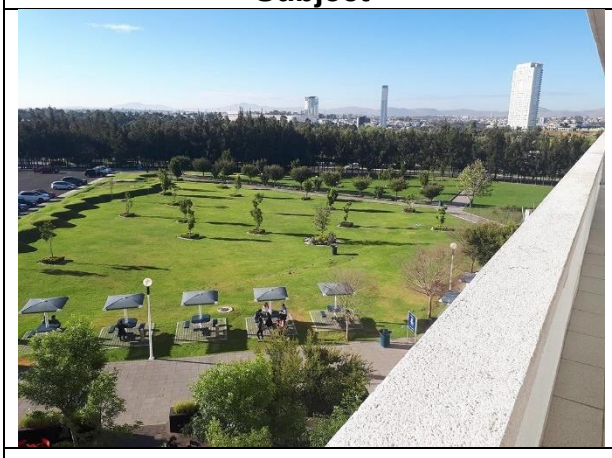
Subject	Annotation
	This is the only bicycle rack that I saw in the campus, it is almost empty, even though the picture was taken at 8:00 a.m. (the same time than in the previous picture, where a full parking lot is seen).

Interpretation

The image communicates that there is still much to do in the promotion of sustainable development in the students. That it is not enough what we have done to sensitize the students in the need of a sustainable development thinking. In the interviews nobody has mentioned the need for reducing the use of cars and increasing the use of bikes, that is why it is important to complement interviews with this kind of methodologies.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Puebla Campus.

The researcher's photograph (13.02.2018), report and interpretation

Subject	Annotation
	This is another picture at the building #3 (the high school). Although there are efforts to have garden areas with local plants that require less water, there are also many areas with grass.

Interpretation

The image communicates that there is still much to do in the promotion of sustainable development in the students. That the University can do more to promote sustainable development education.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Toluca Campus.

The researcher's photograph (25.03.2018), report and interpretation

Subject	Annotation
	This is a small house within the campus, "Ecological House" which is built of tires, glass bottles and ceramic floor pieces.

Interpretation

The image communicates that there are subjects in the curriculum were the students learn to recycle materials and to create products with them. That students are being encouraged to recycle materials .That there are professors concerned with this issue.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Puebla Campus.

The researcher's photograph (13.02.2018), report and interpretation

Subject	Annotation
	When you look at the containers a little more closely, you realize that not all of them are properly labeled to indicate to the user how to separate the garbage.

Interpretation

The image communicates that it can be good that Tec de Monterrey has this initiative to promote sustainable development. But there is still much to do. The University must observe all the details regarding sustainable development education.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Toluca Campus.

The researcher's photograph (25.03.2018), report and interpretation

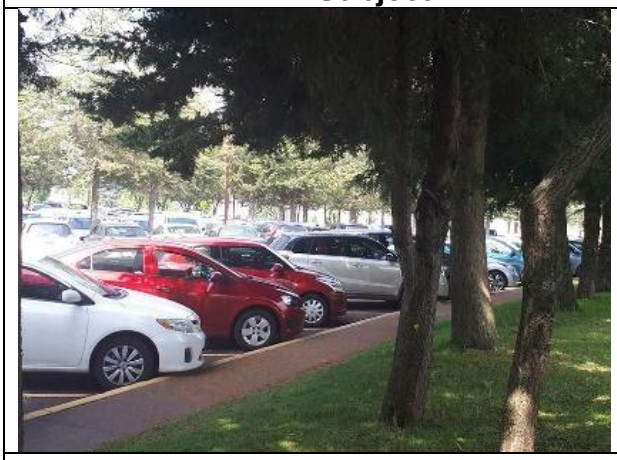
Subject	Annotation
	I was surprised to see that in this campus many students use bicycles and that there is a good signalling to favour its use.

Interpretation

The image communicates that this campus is promoting a culture of sustainability, not only through the curriculum but also in a practical way. SD is something that can be taught not only in a theoretical way. There are still more students who use the car instead of the bike, but this smaller campus sets the example for Puebla, which is the headquarter of the southern zone.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Puebla Campus.

The researcher's photograph (13.02.2018), report and interpretation

Subject	Annotation
	This is a picture of the parking lot at the Toluca campus

Interpretation

The image communicates that sustainability is important for this campus. The parking lot is a very pleasant area, there are many pines and trees that shade the cars and that embellish the landscape. The Puebla campus parking lots, on the other hand, are large concrete platforms that do not have trees to shade pedestrians and cars.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Toluca Campus.

The researcher's photograph (25.03.2018), report and interpretation

Subject	Annotation
	These photographs show a recent initiative of the Toluca campus: they have an area where they care for abandoned dogs, the dogs are feed here and prepared to be adopted by students.

Interpretation

The that the campus is concerned with teaching not only theoretically and directly through the curriculum but also through indirect means and through teaching by example, promoting initiatives like this one. That the campus is concerned about promoting a culture of sustainable development. In the conducted interviews with students, graduates and professors nobody has mentioned this interesting initiative.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Southern Region, Puebla Campus.

The researcher's photograph (13.02.2018), report and interpretation

Subject	Annotation
	This photograph was taken next to the Architecture and Industrial Design building. It shows a habitable module for disaster situations that students designed and constructed. It is light and very easy to assemble and disassemble.

Interpretation

The image communicates that there are professors and subjects that take into account the SD issue. Good initiatives like this one, reinforce the sustainable development culture. In the conducted interviews with students, graduates and professors nobody has mentioned this interesting initiative, that is why this complementary methodology is so useful.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Western Region, Guadalajara Campus.

The researcher's photograph (05.06.2018), report and interpretation

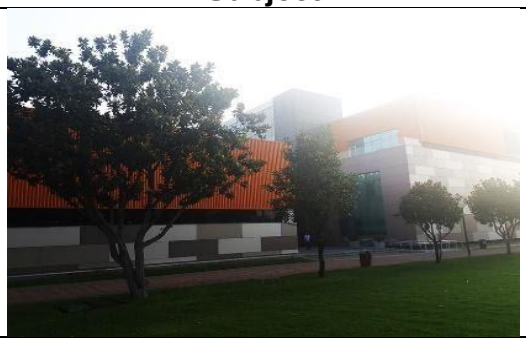
Subject	Annotation
	This photograph shows a student next to a bicycle rack.

Interpretation

Education for SD is being promoted beyond the curriculum, through a culture in the campus. This photograph could communicate that sustainable development is taken into account in the Guadalajara´s campus, as the culture of the use of the bike is being promoted. That there are students that are concerned of being sustainable in their daily routine and beyond the grades at Tec.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Western Region, Guadalajara Campus.

The researcher's photograph (05.06.2018), report and interpretation

Subject	Annotation
	This photograph shows the "Engineering, Architecture and Design Ecosystem" building that was inaugurated on March 2017.

Interpretation

The image communicates that SD should be promoted not only through the curriculum but through sustainable spaces and buildings. An architecture professor told me that the academic architecture department was not invited to the design team. SD education should be thought by example as well as considering the participation and opinion of the users. The same participant also told me that by chance she had the opportunity to see the original architectural plans and she was surprised to see that the north elevation of the building didn´t considered windows, even though that is the most favourable elevation for windows.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Western Region, Guadalajara Campus.

The researcher's photograph (05.06.2018), report and interpretation

Subject	Annotation
	These are some rubbish bins next to a cafeteria. They are used to separate different types of waste.

Interpretation

The same happens here as in Puebla and Toluca, there are rubbish bins that are not properly marked (the one in the right). There is much to do yet to reinforce wat is taught and the practices of the University. None of the interviewees mentioned this situation.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Western Region, Guadalajara Campus.

The researcher's photograph (05.06.2018), report and interpretation

Subject	Annotation
	This is the Innovative Entrepreneurship building.

Interpretation

The image does not communicate something related to the curriculum in a direct way, but an Architecture professor expressed his opinion on the design of the building (that is not efficient in SD terms). He assured that this building consumes 10% of the total energy of the campus, since it was designed in such a way that the main façade faces south-east, a bad decision of the person who designed it. There can be contradictions between the sustainability decisions taken in the campus environment and what is taught to students.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Western Region, Guadalajara Campus.

The researcher's photograph (05.06.2018), report and interpretation

Subject	Annotation
	This is picture of a place inside the campus where people can go to smoke.

Interpretation

There is a contradiction: a campus cannot be "free of tobacco smoke" and at the same time having a place where people can smoke. There is much to do yet. It is of great importance that students perceive congruence between what they learn and what they see (the practices of the University).

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Western Region, Guadalajara Campus.

The researcher's photograph (05.06.2018), report and interpretation

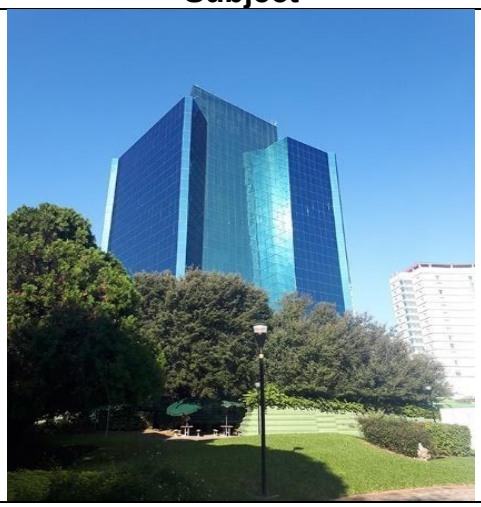
Subject	Annotation
	In this photos we can see the library building that was built in 2013.

Interpretation

One of the architecture professors told me (with deception) that five great trees were eliminated in order to build the library. In the participants' opinion (as an architect), it was a wrong decision to have a glass façade, as the building consumes great quantities of air conditioner. The academic architecture department was not invited to the design team.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Northern Region, Monterrey Campus.

The researcher's photograph (10.12.2018), report and interpretation

Subject	Annotation
	This photograph shows the "Cedes" Building "Centre for sustainable development studies". It was built around 1992.

Interpretation

One of the architecture professors stated that this building consumes great quantities of the total energy of the campus, (in air conditioner) since all the façades are covered by glass, even though the Monterrey´s weather is not suitable for this design. It is important to show the students congruency between the culture of the University and what it is taught in the curricula. In general, the students that participated in the survey did not mention the spaces on the campus, they focused in the curricula, professors and academic activities and projects related to SD.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Northern Region, Monterrey Campus.

The researcher's photograph (10.12.2018), report and interpretation

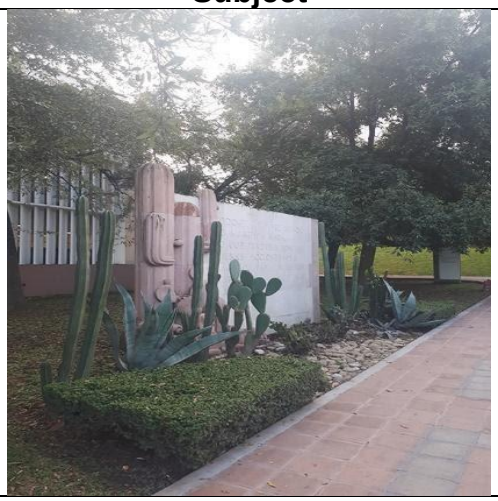
Subject	Annotation
	This photograph shows a building (Aulas 2 or Building #2). The climate of Monterrey is extreme: in summer it reaches 45 ° centigrade. The west facade of the buildings is the most affected by the sun, here we see parasols on the facade of the building.

Interpretation

The campus promotes an environment of sustainability that can be a complement of the curricula. That there are good examples of applied sustainability in the campus that the students can see and live daily. It was not mentioned by the students in the surveys.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Northern Region, Monterrey Campus.

The researcher's photograph (10.12.2018), report and interpretation

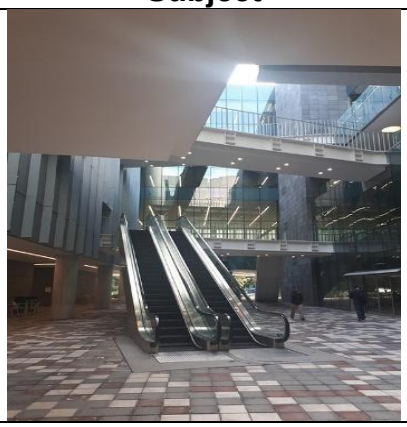
Subject	Annotation
	This photograph shows Mexican native plants in a garden of the campus. These plants have the characteristic that their water consumption is minimal.

Interpretation

Sustainability can be taught not only through the written curricula but also through the life in the campus. There are good examples of applied sustainability in the campus that the students can see and live daily. It was not mentioned by the students in the surveys.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Northern Region, Monterrey Campus.

The researcher's photograph (10.12.2018), report and interpretation

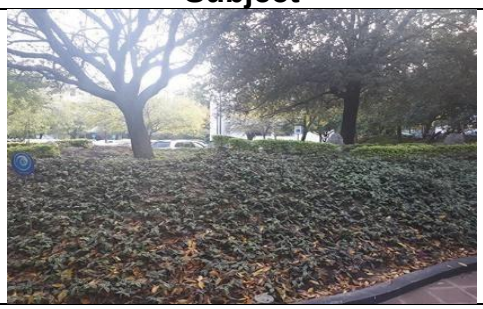
Subject	Annotation
	This photograph shows the electrical escalators of the new library.

Interpretation

The professor who accompanied me in the walkabout process told me that each time that it rains the escalators must be covered by a big plastic to avoid damages in the mechanism. It was not a good idea to put them in an exterior area. It is of great importance that students perceive congruence between what they learn and what they see (the practices of the University).

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Northern Region, Monterrey Campus.

The researcher's photograph (10.12.2018), report and interpretation

Subject	Annotation
	This photograph shows a green area full of native plants that have a very small rate of water consumption in comparison with the gross.

Interpretation

The campus offers different nice spaces for the students. This is solution is better than the one showed in the previous picture. SD is being promoted in different ways and are part of the University´s culture. This was not mentioned by the survey participants.

Location: This photograph was taken outside of the Industrial Design laboratories at the Architecture, Arts and Design School, Tecnologico de Monterrey, Northern Region, Monterrey Campus.

The researcher's photograph (10.12.2018), report and interpretation

Subject	Annotation
	This photograph was taken inside a professors' offices area. They are promoting the recycling of various types of bottle caps.

Interpretation

This photograph shows that sustainability is being promoted also by professors.

G1.2. Curriculum Inquiry Cycle 2 Results

G1.2.1. Results of the trial curriculum intervention

The trial curriculum intervention complete results are as follows:

A total of 83 students were enrolled on the Project Design Workshop course for the August-December 2018 semester at the Puebla campus of Tecnologico de Monterrey. 87% of them participated in this survey.

The Project Design Workshops course comprises the following subjects:

- Design Project 1: 16 out of 18 students participated (89%)
- Product and Services Design (Design Project 2): 7 out of 9 students participated (78%)
- Experiences Design I (Design Project 3): 16 out of 18 students participated (89%)
- Experiences Design II (Design Project 4): 9 out of 9 students participated (100%)
- Products and Systems I: 10 out of 12 students participated. (83%)
- Products and System II: 5 out of 8 students participated. (63%)
- Professional Insertion Project: 9 out of 9 students participated (100%)

Demographic information of the survey:

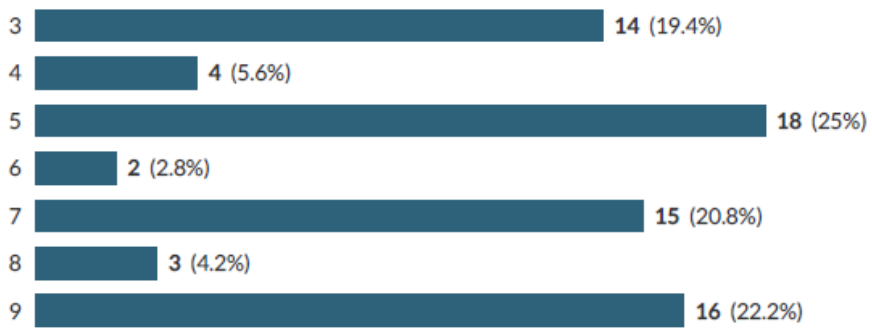


Table 1. Semester in which the participants were enrolled.

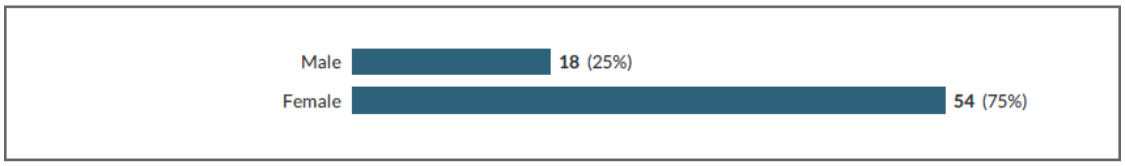


Table 2. Gender of the participants.

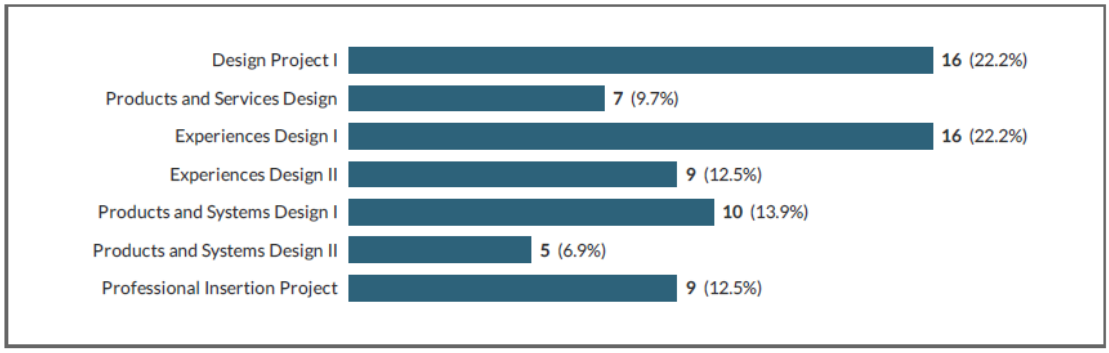


Table 3. Subject in which the participants were enrolled.

The following tables show the results of the participants' responses to the questions of the survey. The numbers 1 to 5 are where 1 means LOW and 5 means HIGH.

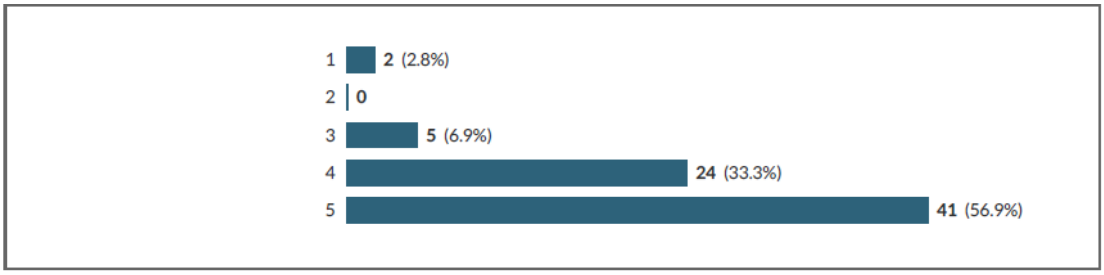


Table 4. How much did you find the projects carried out in the Design Project subject this semester, challenging and inspiring? Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.

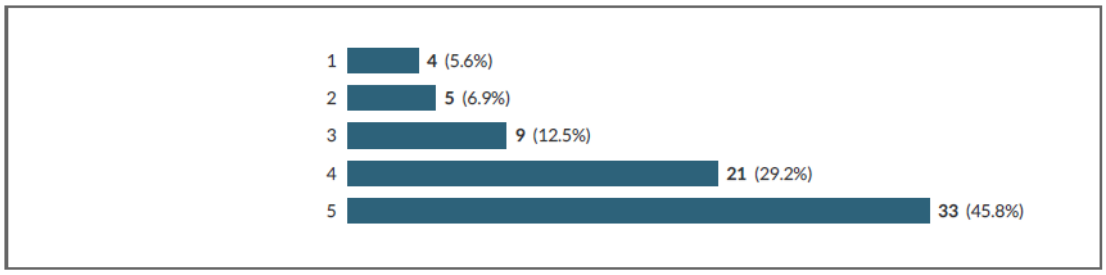
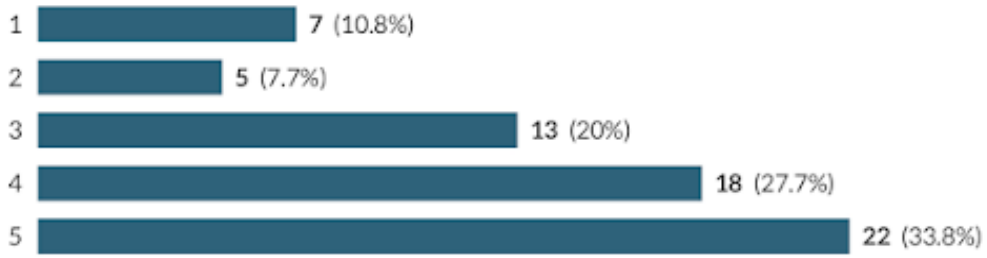


Table 5. How much did you find the projects carried out in the Design Project subject in the previous semester, challenging and inspiring? Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.

Competency 1: *The student´s work demonstrates knowledge and understanding of sustainable development issues locally/globally*. When comparing the two semesters, the graphs show an increase in the percentage of students selecting the highest competency development level (level 5) as well as a decrease in the percentage of students selecting the lowest level (level 1). In the January-May 2018 semester (without the curricula intervention), 33.8% of the students selected the highest competency development level (level 5) and 27.7% selected a level 4. In contrast, in the August-December semester (the trial curricula intervention), 52.8% selected a level 5 and 30.6% a level of 4. In the January-May semester, 10.8% of the students selected the lowest competency development level (level 1). This was, in contrast to the August-December semester (with the trial curricula intervention), in which 1.4% selected this lowest level. See Table 6. The sum of the levels 4 and 5 comparing the two semesters can be observed in Table 11.

January-May 2018 (no changes in the curricula):



August-December 2018 (trial intervention to the curricula):

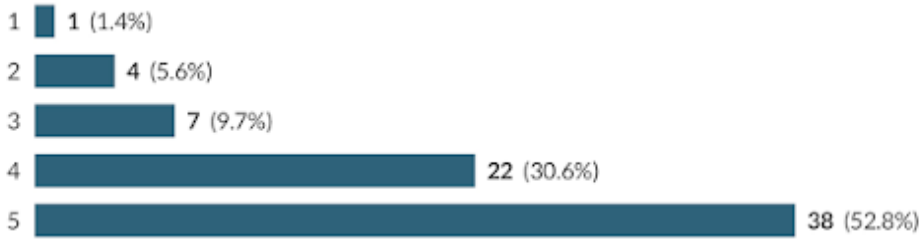
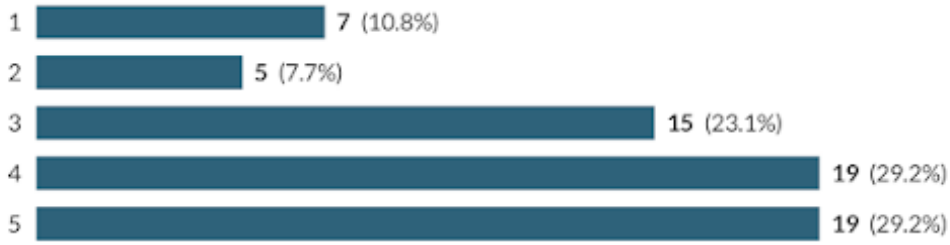


Table 6. Development of the Competency Number 1 in the students' opinion.

Competency 2: The student's work demonstrates a mind-set change in relation to SD through the successful application of the SD principles to her/his projects as well as in her/his own lifestyle. When comparing the two semesters, the graphs show an increase in the percentage of students selecting the highest level (level 5) of the competency development as well as a noticeable decrease in the lowest level (level 1). In the January-May 2018 semester (without the curricula intervention), 29.2% of the students selected the highest level of competency development (level 5) and another 29.2% of them selected a level 4. In contrast, for the August-December semester (with the trial curricula intervention), 59.7% of the students selected a level 5 and 23.6% a level 4. In the January-May semester, 10.8% of the students selected the lowest level of competency development (level 1). This was in contrast to the August-December semester in which 1.4% selected the lowest competency development level (level 1), see table 7. The sum of the levels 4 and 5 comparing the two semesters can be observed in Table 11.

January-May 2018 (no changes in the curricula):



August-December 2018 (trial intervention to the curricula):

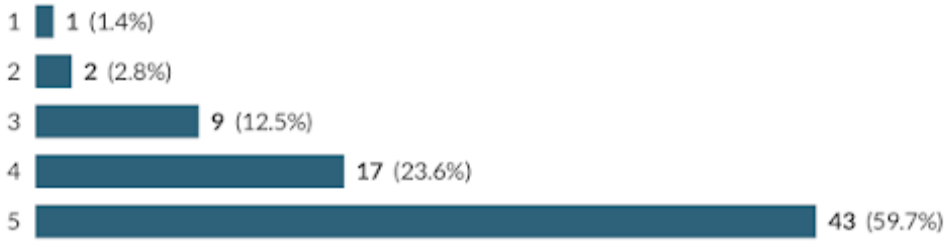
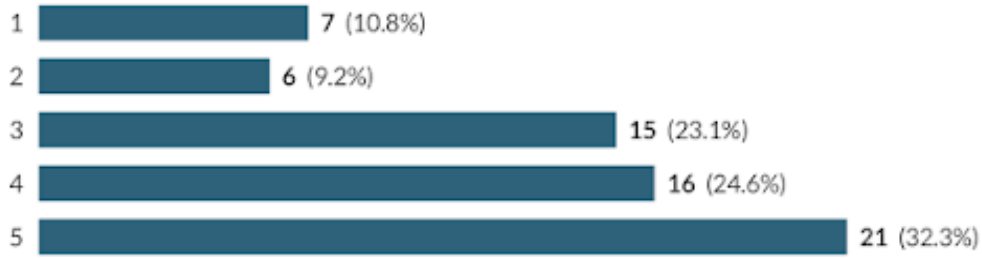


Table 7. Development of the Competency Number 2 in the students' opinion.

Competency 3: The student assesses the life cycle of the product/s of her/his projects based on criteria that relate to the minimisation of the multiple environmental impacts throughout the cycle. When comparing the two semesters, the graphs show an increase in the percentage of students selecting the highest competency development level (level 5) as well as a decrease in the lowest level (level 1). In the January-May 2018 semester, 32.2% of the students selected the highest level of competency development (level 5) and 24.6% selected a level 4. In contrast, for the August-December semester (with the trial curricula intervention), 52.8% of the students selected a level 5 and 23.6% a level 4. In the January-May semester, 10.8% of the students selected the lowest competency development level (level 1). This was in contrast to the August-December semester in which 1.4% of selected the level 1, see table 8. The sum of the levels 4 and 5 comparing the two semesters can be seen in Table 11.

January-May 2018 (no changes in the curricula):



August-December 2018 (trial intervention to the curricula):

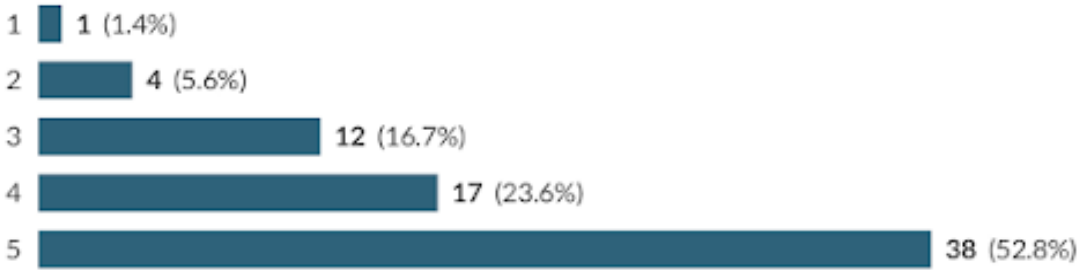
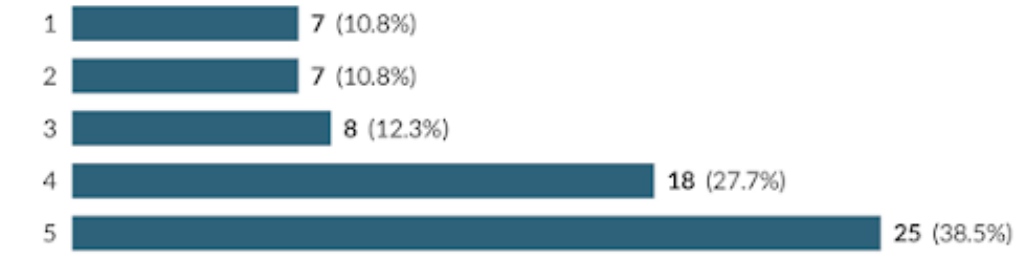


Table 8. Development of the Competency Number 3 in the students' opinion.

Competency 4: The student encourages the rest of the group´s involvement in sustainable development when presenting her/his projects to the group. When comparing the two semesters the graphs show an increase in the percentage of students selecting the highest competency development level (level 5) as well as a decrease in the lowest level (level 1). In the January-May 2018, 38.5% of the students selected the highest competency development level (level 5) and 27.7% selected a level 4. In contrast, for the August-December semester (with the trial curricula intervention), 56.9% selected a level 5 and 25%, a level 4. In the January-May semester, 10.8% of the students selected the lowest competency development level (level 1), This was in contrast to the August-December semester in which 2.8% selected this lowest level (level 1), see table 9. The sum of the levels 4 and 5 comparing the two semesters can be seen in Table 11.

January-May 2018 (no changes in the curricula):



August-December 2018 (trial intervention to the curricula):

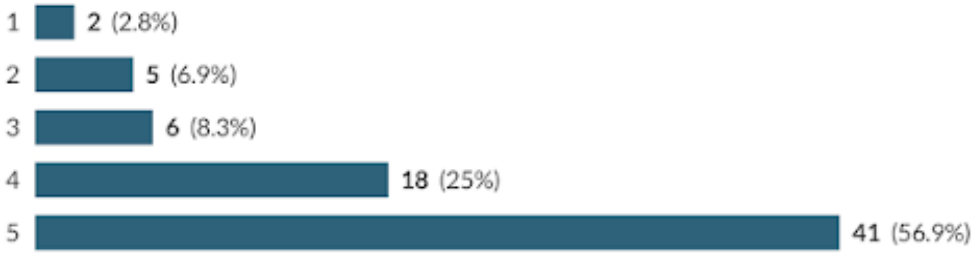
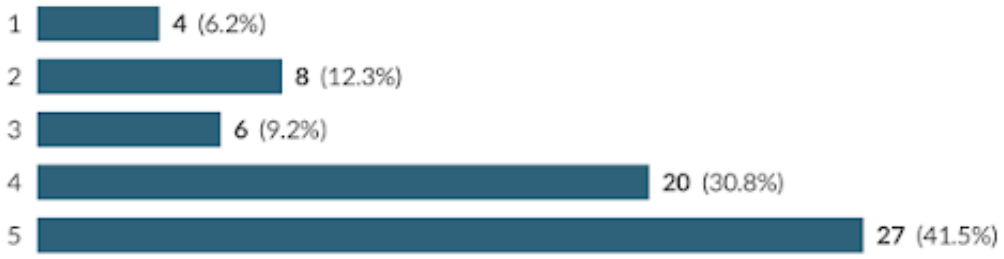


Table 9. Development of the Competency Number 4 in the students' opinion.

Competency 5: The student looks for and finds knowledge inputs and expertise from other disciplines to meet the sustainability requirements that her/his project needs. When comparing the two semesters, the graphs show an increase in the percentage of students selecting the highest competency development level (level 5) as well as a decrease in the lowest level (level 1). In the January-May 2018 semester, 41.5% of the students selected the highest competency development (level 5) and 30.8%, a level 4. In contrast, for the August-December semester (with the trial curricula intervention), 66.7% of the students selected a level 5 and 26.4%, a level 4. In the January-May semester, 6.2% of the students selected the lowest competency development, level (level 1). This was in contrast to the August-December semester in which 1.4% of them selected the level 1, see table 10. The sum of the levels 4 and 5 comparing the two semesters can be seen in Table 11.

January-May 2018 (no changes in the curricula):



August-December 2018 (trial intervention to the curricula):

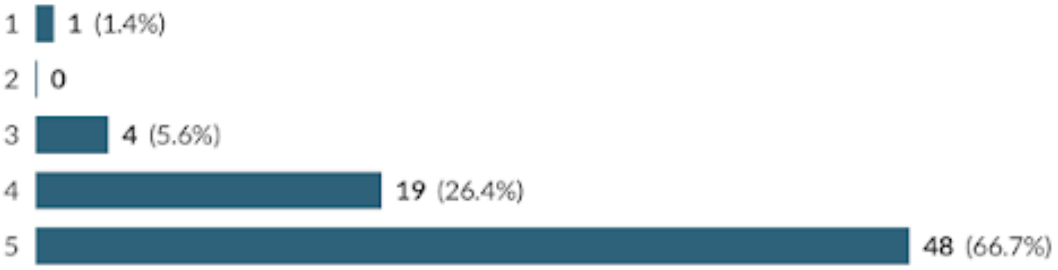


Table 10. Development of the Competency Number 5 in the students' opinion.

G1.2.2. Results of the first curriculum intervention

The complete results of this curriculum intervention application are as follows:

A total of 69 students were enrolled on the Project Design Workshop course for the January-May 2019 semester at the Puebla campus of Tecnologico de Monterrey. 68% of the students participated in this survey.

No students were enrolled on the Experiences Design II course, due to a special project running in parallel.

The Project Design Workshops course comprises the following subjects:

- Design Project 1: 7 out of 8 students participated (88%)

- Product and Services Design (Design Project 2): 9 out of 16 students participated (56%)
- Experiences Design I (Design Project 3): 5 out of 8 students participated (63%)
- Experiences Design II (Design Project 4): No students were enrolled this semester this time
- Products and Systems I: 8 out of 15 students participated. (53%)
- Products and System II: 11 out of 20 students participated. (55%)
- Professional Insertion Project: 0 out of 2 students participated.

Demographic information of the survey:

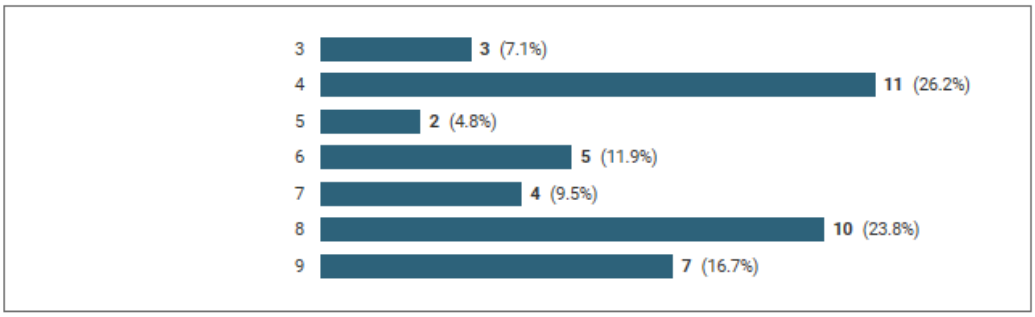


Table 1. Semester in which the participants were enrolled.

Table 2. Gender of the participants.

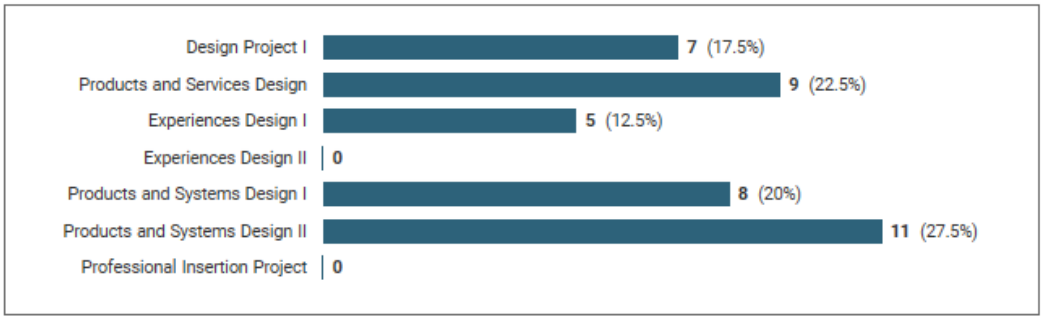


Table 3. Subject in which the participants were enrolled.

The following tables show the results of the participants' responses to the questions of the survey. The numbers 1 to 5 are where 1 means LOW and 5 means HIGH.

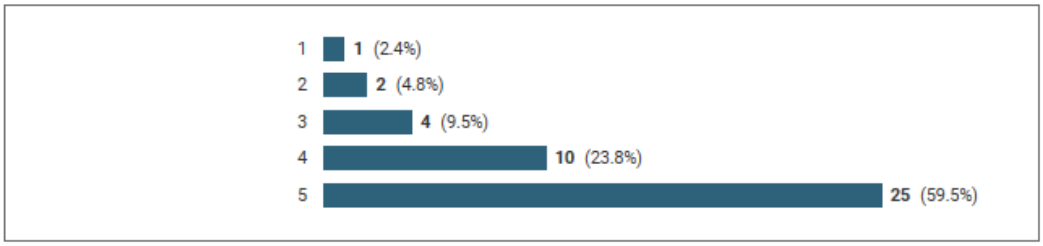


Table 4. How much did you find the projects carried out in the Design Project subject this semester, challenging and inspiring? Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.

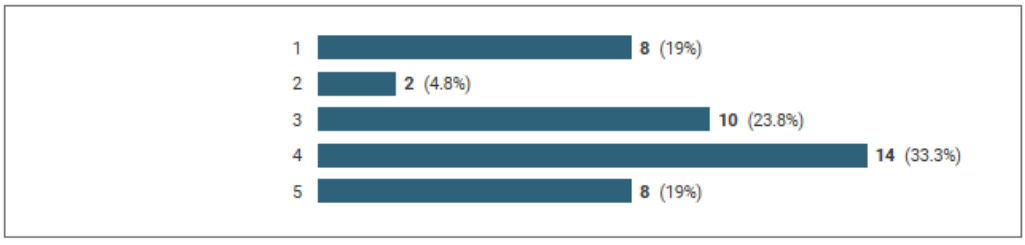
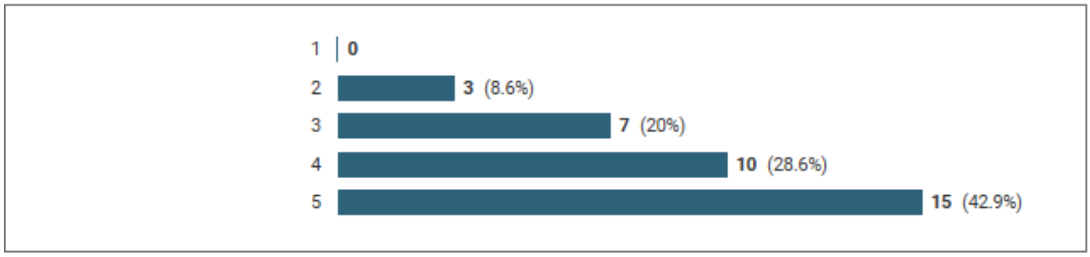


Table 5. How much did you find the projects carried out in the Design Project subject in the previous semester, challenging and inspiring? Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.

The following tables show the results of the participants' responses to the questions of the survey in relation to the development of Sustainability Competencies. The numbers 1 to 5 are where 1 means LOW and 5 means HIGH.

How much did you develop the following competencies this year? Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH. Should this be inserted here?

August-December 2018 Semester:



January-May 2019 Semester:

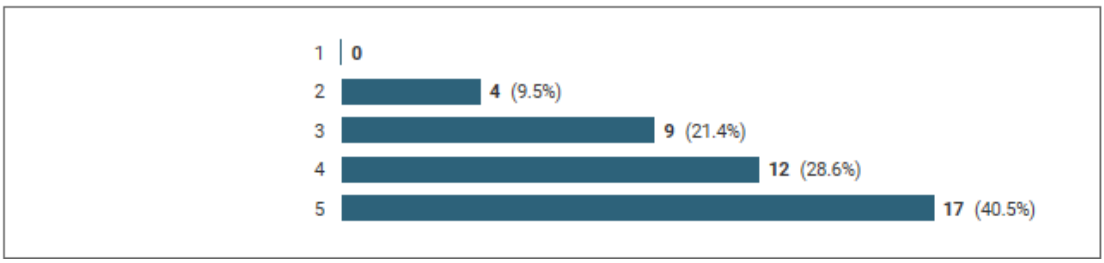
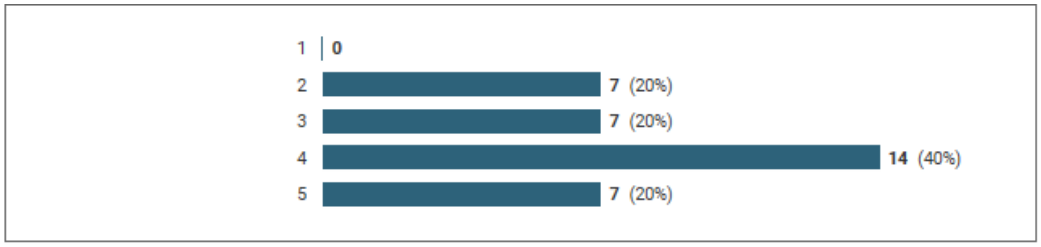


Table 6. Competency 1: Your work demonstrates knowledge and understanding of sustainable development issues locally/globally. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.

August-December 2018 Semester:



January-May 2019 Semester:

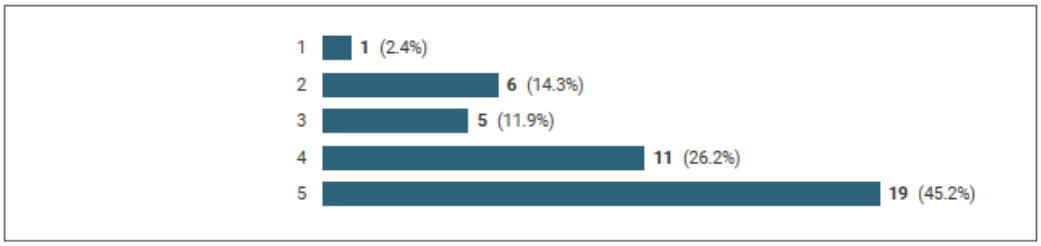
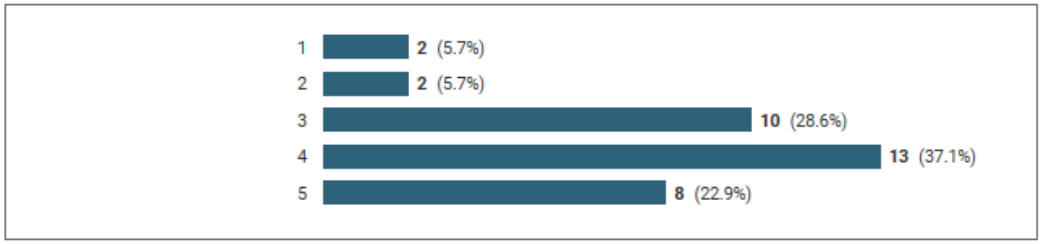


Table 7. Competency 2: Your work demonstrates a mind-set change in relation to sustainable development through the successful minimisation of the multiple environmental impacts throughout the cycle. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.

August-December 2018 Semester:



January-May 2019 Semester:

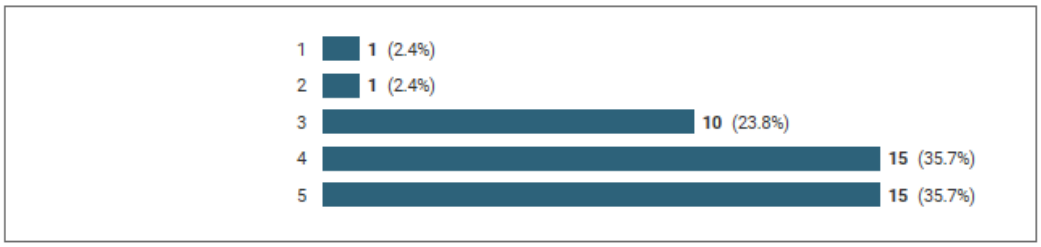
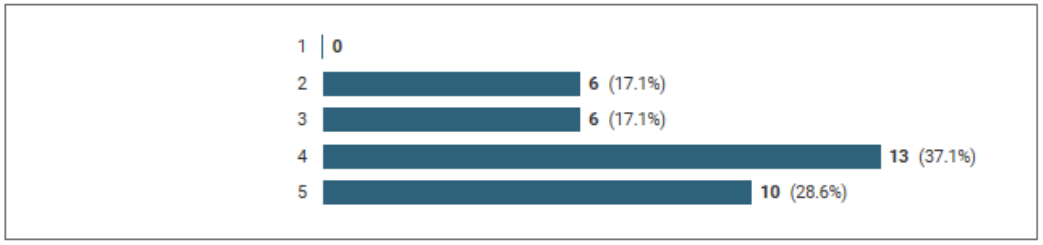


Table 8. Competency 3: You are able to assess the life cycle of the product/s of your projects based on criteria that relate to the minimisation of the multiple

environmental impacts throughout the cycle. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH

August-December 2018 Semester:



January-May 2019 Semester:

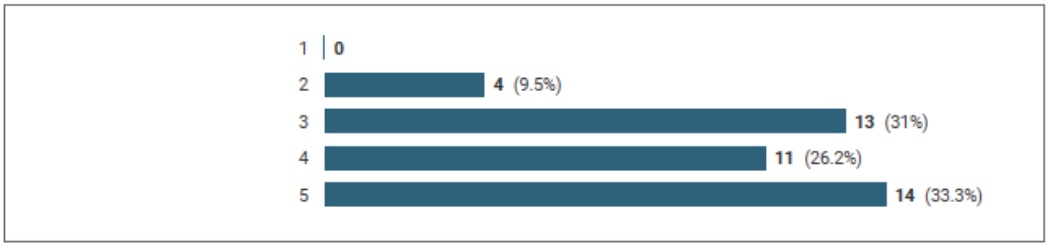
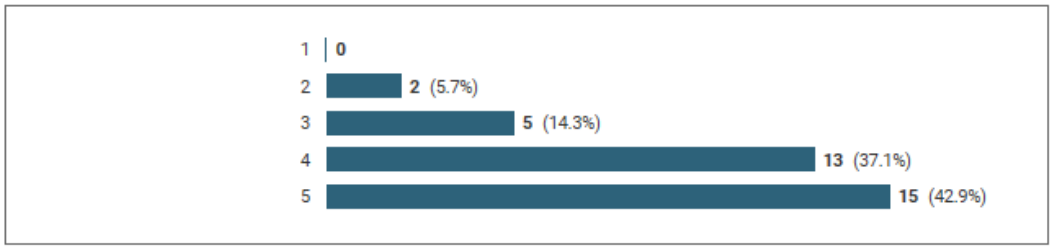


Table 9. Competency 4: You encourage the rest of the group´s involvement in sustainable development when presenting your projects to the group. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH

August-December 2018 Semester:



January-May 2019 Semester:

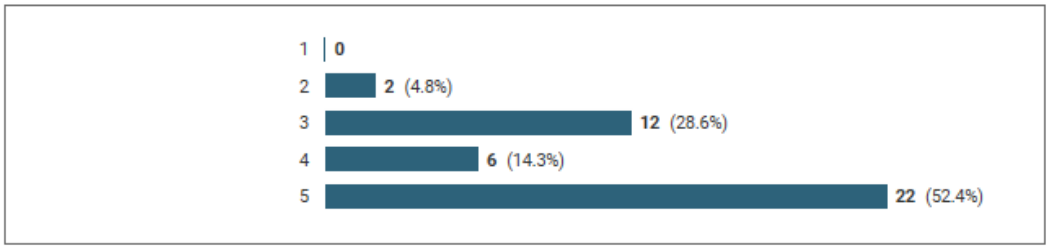


Table 10. Competency 5: You look for and find knowledge inputs and expertise from other disciplines in order to meet the sustainability requirements that your project needs. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH

The next section presents the written comments that the participants provided to support their selection of each of the competencies scores. This is a new section in the survey, the first survey application occurred in November 2018 and the second one in April 2019. For this second application, the students were asked to accompany each response with comments and supporting evidence.

Competency #I. Your work demonstrates knowledge and understanding of sustainable development issues locally/globally.

• My few projects do demonstrate my knowledge and understanding of sustainable development, although I must accept that it was hard for me to understand and carry it out correctly.

• Yes, because the issue of people with different disabilities is something that is present all over the world.

• We did not work hard on sustainability in the first project. We orally saw the subject.

• It is important that teachers give more feedback and help on the materials we should use for the products, they gave us feedback on the service, but not on how to create it.

• Because I have learned new methodologies about design, which enriches my knowledge.

• I would like to do free projects with an ecological approach.

• Throughout this semester in my subjects the desired sustainability issues have not been developed.

• The prospective class was the one that helped me change the paradigm and know everything about sustainable development, rather than projects.

• I did not acquire much knowledge about the subject

• This semester we did not pay much attention to this aspect.

• We need to emphasise sustainable development in all subjects.

• My professor was always very attentive to our needs and answering questions

• I liked the projects, although I do not know much about less polluting materials.

• This semester we did not develop a solution that is related to DS and our project required time in mechanisms and very little on materials.

• I like the dynamics of the class. In this project the environmental issue was not applied much but I love the idea.

• I did not get enough information in class to develop a sustainable design.

• The projects of this semester involved new experiences

• The topic was discussed but not fully addressed

• Well I liked it mildly because we are working with a company but the fact of not landing anything for the semester I do not love.

• I think so since we think about the way of production and materials.

• This semester we focus on the corporate development project, while the past went to the government

• They are projects that go beyond the aesthetic and seek a greater purpose

• We learned about future scenarios, however, being a technological project, the use of components differs with sustainability

• The sustainability focus is not so strong this semester

• Sustainability topics were touched a bit more, however, most of them were not applied because they involved a lot of technology

• Little knowledge of sustainable development was occupied in the current semester

• It seeks to focus projects towards sustainability

• I would like free projects with an ecological approach

• In this semester, sustainability issues were not developed

• I consider that I have an average handling of the topic, but in general I do not apply it in the whole project

• Yes because we are working with a real environmental problem

• Five, because it is a project involved with cleaning the Atoyac

• Because in every project the teachers always put a lot of emphasis on thinking about the whole life cycle of the products

• The project makes us involved in local sustainability issues, so the application of the concepts is more dynamic and understandable

• In all our classes we must find the way in which our project or product is 100% sustainable

• We are working to raise awareness and involve citizens on issues of sustainable development

• Yes, because in the subject they taught us a lot about the importance of sustainable development, as well as enriching what we already know

• Yes because of the approach towards the Atoyac River and the sustainability analysis of the device.

Competency #II. Your work demonstrates a mind-set change in relation to sustainable development through the successful minimisation of the multiple environmental impacts throughout the cycle.

• I realised that I was only applying the principles of sustainable development in my projects, so I made the decision to apply them in my daily life to have greater impact and that the benefit was greater.

• Yes, because I realised that as a designer I have a lot of responsibility in the environment from the moment I start designing.

• The challenges that were presented inspired me to change some habits.

• I believe that the performance and / or development of skills was not the best but not the worst, since I could say that my previous bases were not the best compared to the rest of the students. But this semester I had a lot of experiences and acquired knowledge that I will apply in my future semesters.

• Yes, because I have seen that taking care of the environment is very important.

• More organisation is needed.

• This semester has been especially complicated in my personal life, positive actions that I planned to apply, at the end I did not carry out as I wished.

• I did not have a big change in this topic, but I did learn some new things.

• It has been useful to learn about sustainable development for my daily life, but in current projects we have not considered them.

• Phillip always has a positive attitude that spreads and encourages us to become more involved in the project and feel proud.

• I liked the past projects compared to this in terms of the materials, since the impact on the environment was lower.

• Sustainable Development must be considered in every design / product / experience

• I would have liked to focus more on the sustainability of my design, but there was not enough time.

• It was achieved by seeing the subject from the perspective of the real industries

• Well, it was my personal semester project i and I liked it

• Sure, since we think of only using what is necessary and maintaining the essential aspects in the best way.

• Unlike last semester, this semester my project focused more on emotions and experience

They were good projects that involved us with other careers

• Personally I try to apply conscience according to the principles, however, in the project it was complicated to apply them

• I have not reconsidered things in my personal life

• I reduced the levels of waste, I will not tolerate the excessive use of products harmful to the planet

• Every time I feel how my environmental sense and commitment increase

• Yes because in many subjects we have been taught the subject

• 3 because the paradigm does change, but not in my personal life

• Because in my daily life I take actions to help reduce pollution and damage to our environment

• I have changed the way I see things and I try to have a more sustainable lifestyle

• Also in my life I have changed certain habits to be optimal in my attitudes even in my moods

• I am increasingly trying to reduce my carbon footprint I have changed to a more sustainable and responsible lifestyle

• Yes because they make me realise what is really happening in the world and how it affects us

• Yes, because we learned many principles about sustainability

Competency #III. You are able to assess the life cycle of the product/s of your projects based on criteria that relate to the minimisation of the multiple environmental impacts throughout the cycle.

I consider that I am able to evaluate the life cycle of the products and above all that I can design products minimizing the environmental impact in order to live in a world with less waste.

• Yes, in terms of materials and manufacturing methods.

• When making a toy in a short time, we do not experiment with materials. The second project does have more sustainable development.

• A lot because I've learned the importance of thinking about the product and its destiny after its useful life has ended.

• Yes, I can evaluate it, but I have neglected it.

• I think I have more awareness, but I do not consider myself capable of evaluating it

• We have the knowledge, but we do not apply it

• There is a lack of information about materials to be able to evaluate the life cycle of each product that we are going to make.

• The professor invited people to complement their classes with themes of innovation, sustainable development, motors, creation dynamics and took us to Mexico City to learn more about the real world of design.

• I think that in the subjects they do not teach us much about this topic, because only those topics are addressed (much more) in specific subjects such as biodesign in the LDI17 plan

• Theoretically it is achieved, but it would be ideal to reach a next stage

• I learned a lot about Sustainable Development!

• I believe that this aspect remains the same because we were already doing the action beforehand

• The first one was totally focused on sustainable development, while the second only covers some aspects.

• We take into account the damage that its components can cause, however, there are not many ways to reuse them.

• A little more reflection is needed

• Yes and to identify current problems and not let myself be carried away by fashions if not by real changes that generate impact

• I am not fully informed to know about the process

• Completely because we are learning from materials and processes

• 4 because the project was related to a part of this topic, but it was not so thorough

• Yes, we always review each stage of the development of a product to minimise its impact on the environment

• Before I did not think so much about the life cycle of the product now I can clearly see all the phases that the project will go through

• Learning about materials is how we have learned to evaluate sustainability

• I am carrying out a project in which the use of resources is minimised and we give it a long life time

• Yes, because I have learned it in my classes they taught me the importance of sustainability and how it affects the environment

• Yes, it is an important parameter for the components that we will use

Competency #IV. You encourage the rest of the group´s involvement in sustainable development when presenting your projects to the group.

• I always try to involve sustainable development in my presentations so that my colleagues feel motivated and can follow the same path that will have great benefits in the long run.

• Well, not so much, because there are not always people open to learn about this topic.

• I am not sure that I was inspired by this topic, but I try to do it.

• I think so, because we all understand the importance of preserving the environment.

• Freedom to work as you are comfortable.

• It seems to me that if I am able to motivate and sell my projects

• There was no time to apply it

• Depending on the theme of the project, you get to talk about sustainable development.

• The teacher knew how to instill the discipline and organisation of times to develop our project.

• By presenting our work to other colleagues and applying their criticisms.

• Although Sustainable Development is part of the priority criteria in the project brief, it is not the most important

• It is about looking to project considering the DS but sometimes it is not taken into account

• I believe that the motivation in general is not for sustainability

• Generated a deeper impact since the project was directly linked to the problem

• Technological development is difficult to take hand with sustainability, it is not impossible, but if more complicated

• There was not so much emphasis on that part of the project

• Yes, I like to talk about everything I learn and create awareness

• It is about motivating people to look for this approach, although sometimes we deviate a little

• I want freedom to work as is right for me

• I have not been able to apply it 100% to my projects

• We always enrich the projects with what we learn

• 3 because it was not so motivational

• Yes, we always discuss these issues with our teams

• Sustainable development is a current issue that should be treated more and consciously so I try to involve the rest of the group and my projects on this topic.

• I would like that to happen, maybe it happens with my fellow designers but it does not happen with the colleagues from other races

• The project we are doing for the Atoyac River motivates others to care about the environment

• Within the school itself because it makes me more interested in the environmental problems that exist around me.

• Yes, because it is a requirement of the device.

Competency #V. You look for and find knowledge inputs and expertise from other disciplines in order to meet the sustainability requirements that your project needs.

• I try to incorporate my knowledge and experiences from other disciplines to achieve compliance with the sustainability requirements that my projects need. Although I believe that I must continue learning and researching to carry out better projects.

• Yes, because there is always one subject of my other subjects to make these projects.

• I used all the knowledge I have to develop both projects.

• I believe that the performance and / or development of skills was not the best but not the worst, since you could say that my previous bases were not the best compared to my colleagues. But this semester I have a lot of experiences but mainly learning to apply in my future semesters.

• Finally, I think that I did implement to some extent some ideas on how to help the environment based on past experiences.

• I totally agree with this, since a lot of knowledge is needed to develop projects.

• If attempted, but due to the difficulty of the project

• It was achieved by leaving the area and calling experts

• It is always important to remember what you have learned in other subjects. Not only for sustainability issues

• Yes, even marketing and design matters

• Nowadays, we cannot design anything without taking into account that concept (SD)

• On both occasions we had to resort to other areas to achieve our objectives

• We try to incorporate elements in the parts that are most possible

• Multidisciplinary projects are necessary in projects

• Yes, it gives a plus or "added value" to each object currently

• Knowledge of other subjects was incorporated

• The prospective subject provided us with tools that help us to follow this sustainable approach

• I try to use all the tools I have available

• Almost not because sometimes we forget this topic

• 5 because the project requested it

• Yes, we always incorporate what we learned before

• Last semester I did not learn much about this topic and this semester we have applied it more and better but it is the only subject where I saw it in depth

• In this matter we have managed to involve many other disciplines

• According to what I have learned in other semesters now, sustainability goes beyond making recyclable products

• Yes, because with all the problems that I know the environment has, it is important for me to seek help to improve and make a positive change in the world in which I live.

• Yes because we involve many aspects that we saw in manufacturing processes.

Professors reflections and comments

For this intervention, after applying the survey to the students and collating the responses, the inquirer interviewed the professors who taught the Project Design Workshop courses, as a validation process. For each group, one of the survey questions? answered by the students was chosen at random and the results were shared with the professor. In addition to requesting their reflections and comments, the professors were also asked to share (if they wished) the contents and any additional material related to sustainable development that they had used in their class. The results are shown below.

Design Project 1. Professors A and B (Grecia Brito and Martha Nunez)

This semester the students developed two projects: in the first term they worked in pairs to design a toy for blind children of a school in Puebla, which were donated to them at the end of the semester. The second project consisted of designing a product for a category of the Royal Society of Arts contest that seeks to solve urgent problems of humanity through design thinking. This is the first Design Project course that students take in their intended career, and both teachers wanted them to start with projects that stress the importance of sustainable development in product design.

Product and Services Design (Design Project 2). Professor C.

‘In this class we carried out a project for the company Bosh, a dishwasher. The student Pedro (whose survey was chosen at random in this group) was on the winning team and that particular student was one of the best in the group. He considered the issue of sustainability by proposing a dishwasher with a saving of 60% water and time savings, but when I asked them to justify how this savings was achieved, they could not do it because they did not elaborate a functional prototype that could compare their product with other conventional products. For this reason, for the final presentation of the project to the company, I asked the students not to mention the issue of water savings because it is not demonstrable at this time, but they did mention the time savings because that part was demonstrable. Pedro´s team won the competition, (according to the company).’

When asked about the contents and assessment criteria that he included in this class, he said:

‘For the subject of projects 2: I have not given much attention to sustainability, but I teach them the Eco-it software to compare different materials for their products: (https://www.environmental-expert.com/software/eco- it-software-182649). About how I consider the criteria of sustainability in the evaluation of students: I think that sustainability is very complex and this semester I perceived it too complicated to apply in the subject of projects 2. The students still do not show enough domain of the subject to reach an acceptable result. I noticed, for example, that a team mentioned that its design was sustainable, but they could not justify how they achieved it’. ‘As I write this, I realise that for this subject I need more to teach the students on the subject of sustainable development.’

Experiences Design I (Design Project 3). Professor D. Once the results of the randomly chosen survey of this group were shown, the teacher commented:

‘I had this same group of students last semester and I saw that this semester improved a lot, one of the teams won recognition in the final exhibition of The department director asked me to include in this subject the subject of in-depth

ergonomics, as well as the subject of interpersonal relationships, the issue of sustainable development included talking to them about the product's life cycle and the circular economy The way to evaluate sustainability was within the rubric of design, problematisation and context'.

Experiences Design II (Design Project 4)

No students were enrolled in this course during this period, due to a special project running in parallel.

Products and Systems I (Design Project 5). Professors A and D.

'In this class the students worked in teams of 5 members, the objective was to develop a product in collaboration with the physical sciences institute of the National Autonomous University of Mexico (UNAM) and the Municipal Hydrology Center of the Atoyac River (CEMUHI). The product consisted of a monitor with technology to measure the toxicity levels of the Atoyac River. The students conducted an investigation because there is currently no way to control and know which companies or people are dumping waste into the river, there are many clandestine downloads. The students designed a device capable of housing technology developed by the institute of physical sciences, which could be installed in the river. Very high quality prototypes were obtained and donated to CEMUHI. The student selected at random (María del Carmen) was a very committed student, the design of her device was very different from that of the other students, as she considered it to be a very resistant product, capable of withstanding the impacts and tensions in the river". Professor Grecia accepted to share with the inquirer the 3 presentations that she uses to talk about Sustainable Development to the students'.

Products and System II (Design Project 6). Professor C

‘The student selected at random belongs to the winning team of the competition that took place in this course. I asked the students to work in teams of 3 members, they made a design for the Steelcase company. An important requirement of this project was a drastic or profound innovation applied to the design of a modular furniture that could be adapted to the needs of the user. The student whose survey was chosen (Juanita) always showed initiative and interest in sustainability issues for her project’.

When asked about the contents and assessment criteria that he included in this class, he said:

‘In the subject of Systems 2 I have applied the ViP method (https://www.bispublishers.com/vision-in-product-design.html), which deeply "re-considers" existing products to achieve sustainable advantages (although not it is the primary goal of the method). In the matter of systems 2, the students did have more mastery of the subject, but it was a big challenge for them to apply the method. I take the task of having more attention to sustainability in the next semester, if you have ideas or tips, they will be very welcome!’

Professional Insertion Project (Design Project 7)

Only two students were enrolled in this course during this period, none of them answered the survey. Professor E commented:

‘The book I ask the students to read is "Emotionally Durable Design, Objects, Experiences & Empathy" by Jonathan Chapman. And I ask them to consider among the issues that sustainability will work on. In this semester I had only 2 students, and of them (Julián) in particular, addressed the issue of water, in which he analysed the water cost in homes and proposed a project to address that problem specifically in the showers (at the time of bathing)’.

G1.2.3. Results of the second curriculum intervention

Product Design Programme

1. Survey Results

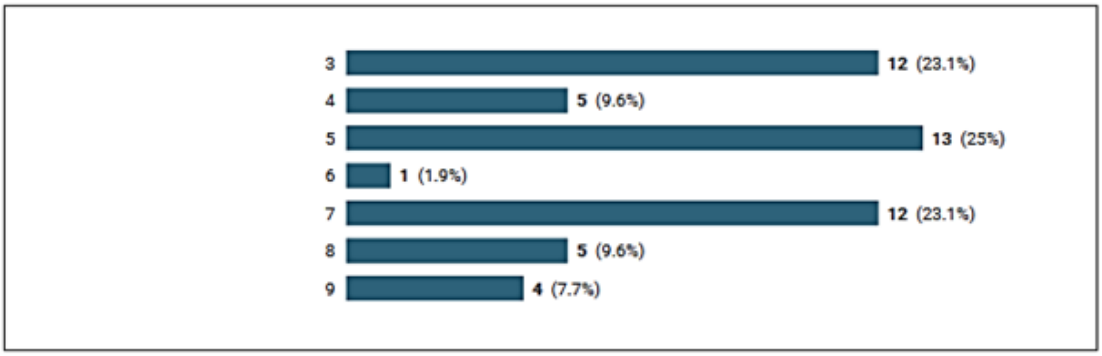
A total of 82 students were enrolled in a Design Project course for the August-December 2019 semester at the Puebla campus of Tecnologico de Monterrey. 63.4% of the students (52) answered or participated in the survey.

The Design Project courses comprise the following subjects:

- Design Project 1: 13 out of 19 students participated (68.4%).
- Design Project 2: 5 out of 6 students participated (83%).
- Design Project 3: 12 out of 19 students participated (63%).
- Experiences Design II (Design Project 4): 0 out of 7 students participated.
- Products and Systems I: 10 out of 11 students participated (91%).
- Products and System II: 10 out of 10 students participated (100%).
- Professional Insertion Project: 2 out of 10 students participate (20%).

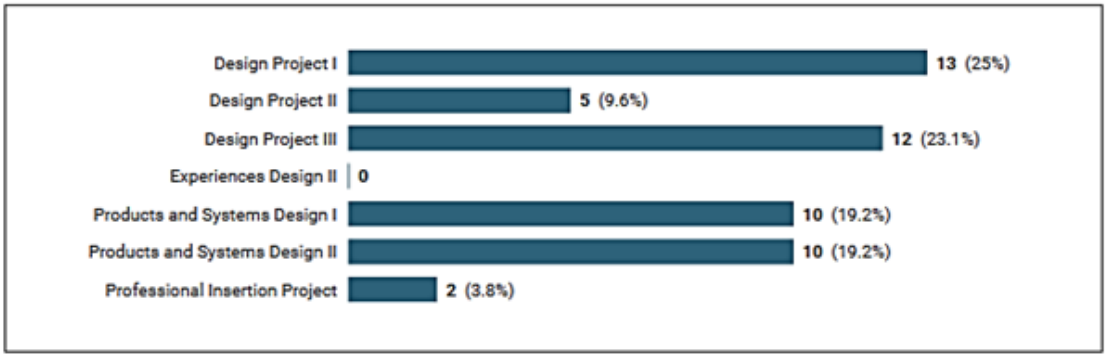
Demographic information of the survey:

I. Semester in which the participants are enrolled:



II. Gender:

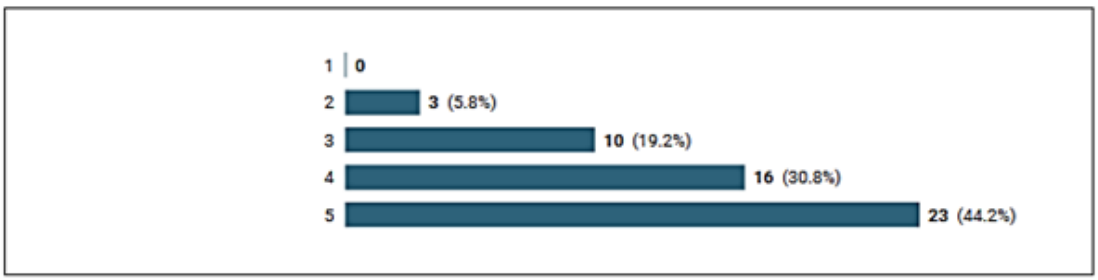
III. Subject:



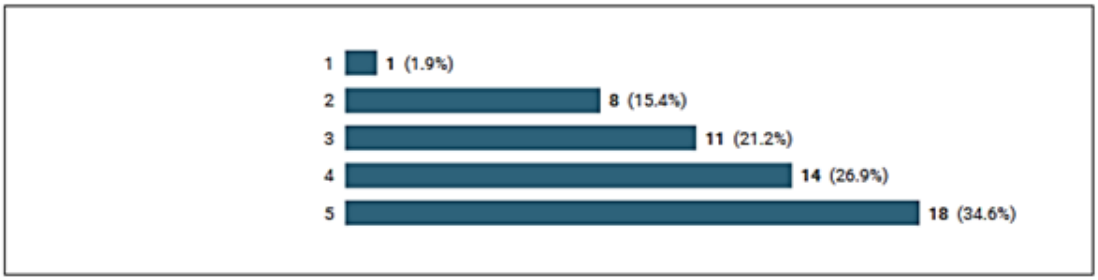
*Note: The percentages at the beginning of the document represent the total number of students who participated for each subject. In this table, however, what is shown is the percentage of participants that belongs to each subject, of the total number of participants.

The following tables show the results of the participants' responses to the questions of the survey. The numbers 1 to 5 are where 1 means LOW and 5 means HIGH.

1. How much did you find the projects carried out in the Design Project subject this semester, challenging and inspiring? Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.



2. How much did you find the projects carried out in the Design Project subject in the previous semester, challenging and inspiring? Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.

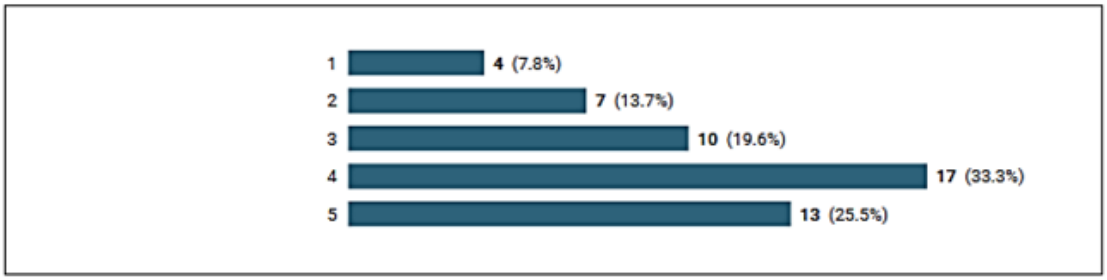


The following tables show the results of the participants' responses to the questions of the survey in relation to the development of Sustainable development Competencies. The numbers 1 to 5 are where 1 means LOW and 5 means HIGH.

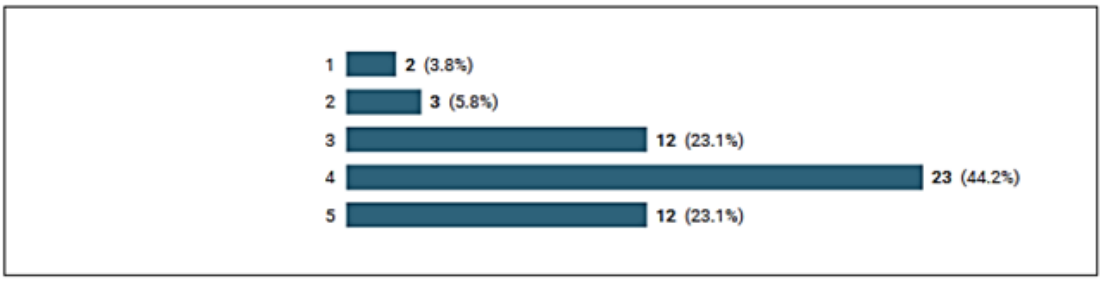
3. How much did you develop the following competencies this year? Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH. Should this be inserted here?

I. Your work demonstrates knowledge and understanding of sustainable development issues locally/globally. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.

January-May 2019 Semester (previous semester):

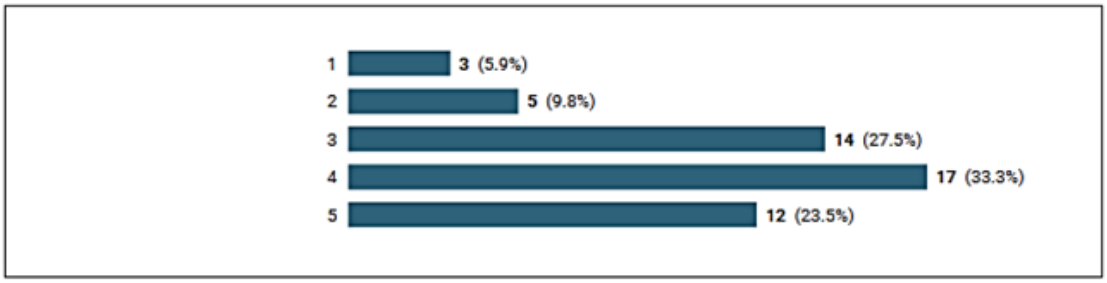


August-December 2019 Semester (current semester):

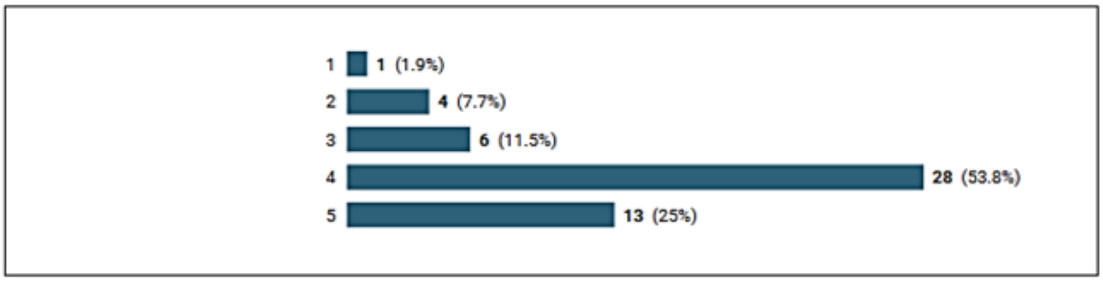


II. Your work demonstrates a mind-set change in relation to sustainable development through the successful minimization of the multiple environmental impacts throughout the cycle. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.

January-May 2019 Semester (previous semester):

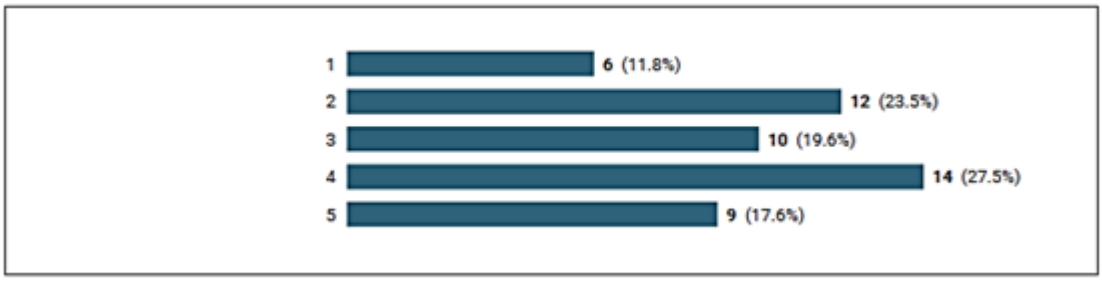


August-December 2019 Semester (current semester):

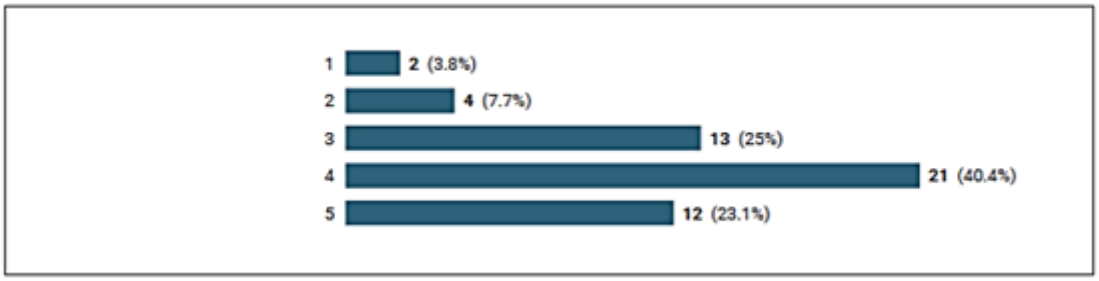


III. You are able to assess the life cycle of the product/s of your projects based on criteria that relate to the minimization of the multiple environmental impacts throughout the cycle. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH

January-May 2019 Semester (previous semester):

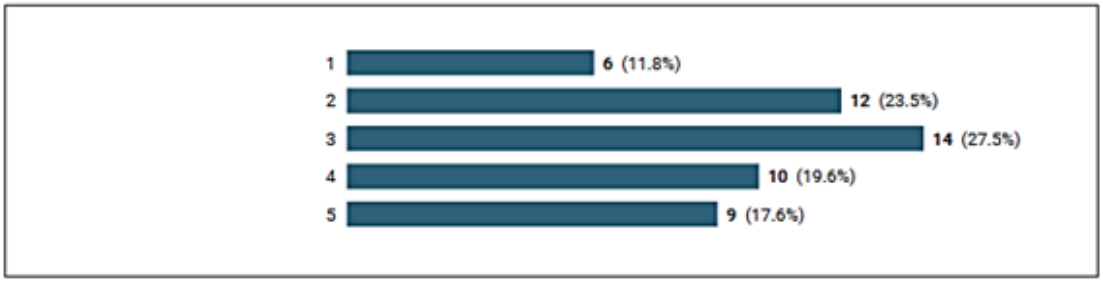


August-December 2019 Semester (current semester):

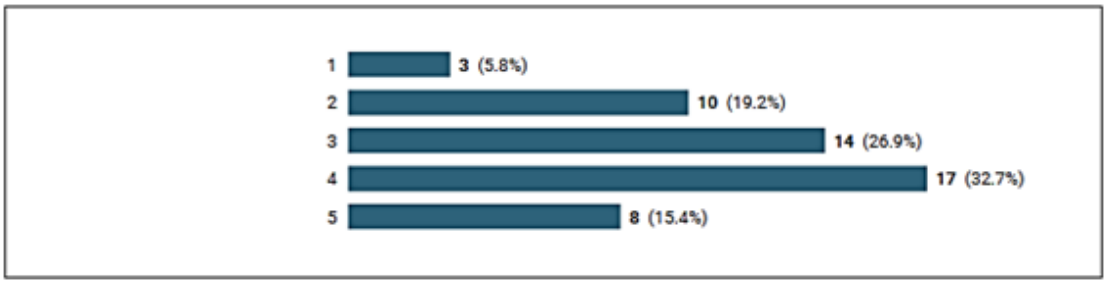


IV. You encourage the rest of the group´s involvement in sustainable development when presenting your projects to the group. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH

January-May 2019 Semester (previous semester):

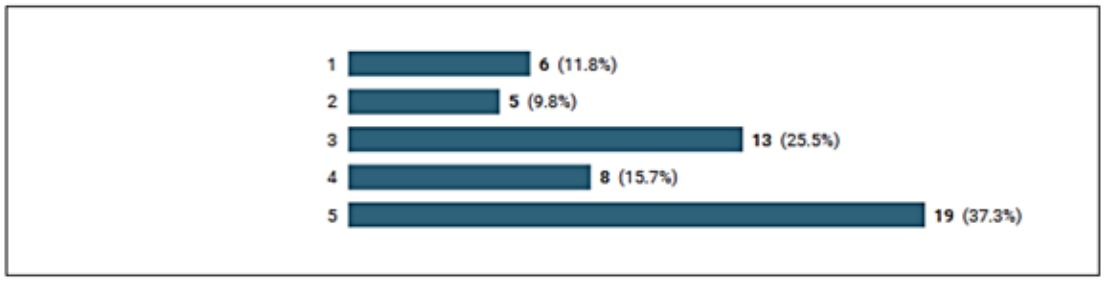


August-December 2019 semester (current semester):

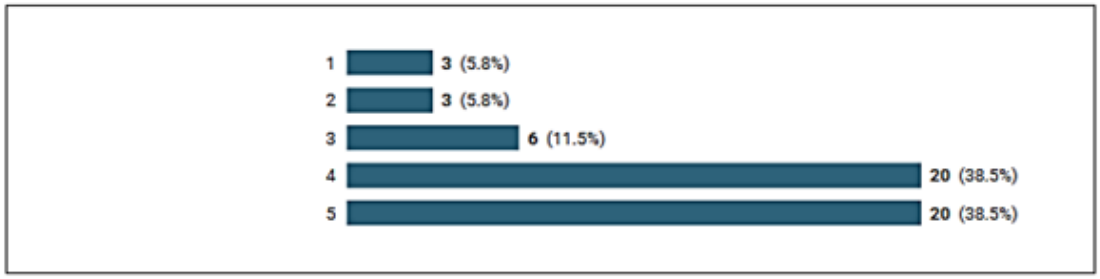


V. You look for and find knowledge inputs and expertise from other disciplines in order to meet the sustainability requirements that your project needs. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH

January-May 2019 Semester (previous semester):



August-December 2019 semester (current semester):



The next section of this document presents the written comments, which the participants provided to support their selection of each of the competencies' scores. This section in the survey was introduced in April 2019 (the first survey application occurred in November 2018), the second one in April 2019 and the third one in November 2019. For the second and the third application, the students were asked to accompany each response with comments and supporting evidence. This was considered relevant to ensure that the participants selected the most accurate value in the survey and that they reflected on the competencies they developed.

I. Your work demonstrates knowledge and understanding of sustainable development issues locally/globally.

- We didn’t work too much last semester in these topics and in this semester, we are really working on it, now I know that we have a lot of challenges to solve;

- The material that I will be using for my project is reusable and recyclable;

- My current project is a sustainable product because it considers the 3 axes of sustainability. I have developed a container for microalgae house, which in addition to cleaning the Co2 at home, provides additive superfoods to liquefy them;

- In the realization of the products we made in class, we thought about ecological and non-disposable materials;

- With topics that were seen and taken into account in the class, which demonstrates the knowledge of this topic in the projects;

- We learned about 5-year trends, many involved the environment;

- Last semester I did not learn anything in fundamentals class 2
- This semester we are collaborating with Sportcast, a 3D printing company and we are integrating knowledge of sustainable design for our new development

- Critical study on what happens or happened in the country, trends

- You are more in the development phase of the project or when evaluating consumption trends in the future

- Our concept can apply for principles 8 and 9 to encourage decent work through innovation

- The themes of the project are interesting and attractive

- From the beginning of the project I mentioned the importance that this should be sustainable

- I thought about developing a product that prevents sun damage at the time of doing and that this was made with recyclable materials

- We make the project from research to the final prototype, We go through different processes such as ethnographic observation

- Evaluation of current trends

- I have been able to hear about these types of projects, however we have not materialized them in the projects

- The project that I have been developing throughout the semester seeks to improve a certain situation that involves the excessive and inappropriate use of garbage bags

- In the materials section we choose non-harmful materials for the planet, with the knowledge of the previous semester I now know that we can replace to have a better performance in the labor field to obtain a better economic growth for the country

- We have used recycling companies which has opened a panorama of things we did not know, we can feel what it is like to work for these companies

- I would like to appreciate more the issues of sustainable development, however, for now, at the point where I am now, I have not yet dealt with them

since I am fully concentrating on the solution of an unrelated problem but I would like to work more on it.

- I still have a lot to learn but everything I learn I apply to my studies

- Yes, because this semester the subjects have been focused on sustainable development
mainly local, because they are focused on problems in Mexican society

- The current project does not focus on sustainability and the environment

- Last semester we made a device that detects certain parameters in the Atoyac River to help with pollution.

- The teacher did not literally explain the subject, it is not a class theme, it has only given us tools that have helped us find insights so that our project is sustainable

- Because I think we are aware of everything sustainable but it did not have an application in the development process

- by developing more research I realize what is in my environment

- I still don't define project

- this semester we got involved with children which was a very good thing because we have all passed that stage and it is easier to know how a child thinks than an adult

- yes, it is a project focused on the true needs of the user

- I am looking to implement biometrics in my designs

- they show that I have knowledge on sustainable development issues however I need to understand the term well

- thanks to the material transformation matter I have known various materials obtained from various sources of raw material as well as a transformation process for its possible application I have understood how it pollutes and damages the environment

- I am looking to use environmentally friendly materials

- Project that helps improve medical services

- One of the requirements for the project is that the product is based on an international call in this case united nations

- My project has nothing about ecodesign or sustainable

- The current project does not notice much the use of materials

- Prototypes with many materials that cannot be recycled so easily

- The material used is generally not harmful

- We do not focus on the sustainable

- The project focuses on people and how to improve their lifestyle emotionally

- I think that somehow they do it since the subject and the situation are very present which makes us more sensitive

- Looking for the minimum consumption of plastic

- On the sheets of the working progress I presented what my project was about
- My previous semester was semester i, a much more complete experience than this semester

- Comparing a little this semester I was not 100% focused on the subject of projects due to the other subjects

II. Your work demonstrates a mind-set change in relation to sustainable development through the successful minimization of the multiple environmental impacts throughout the cycle.

- Despite not changing more products currently at home, I now understand the need for sustainability in product design.

- We have seen in class examples of everyday products that do not harm the environment

- the subject is increasingly seen by which the paradigms can be extended quite a lot

- I improved a little in the way of developing projects

- After taking perspective class in industrial design I have tried to incorporate more ecologically responsible habits into my life

- Explanation of what civic design is and how it positively influences the masses

- I learned to think about projects that are not necessarily carried out through a product, think about services

- yes, improve it and take advantage of it, improve each person's time

- The products that we intend to intervene is with the objective of helping people to lead a more sustainable life

- I always try to generate the minimum amount of garbage and if I generate it that is biodegradable

- My project this semester is based on home gardens, so the experience is good.

- It really comes out in my lifestyle only

- Yes, in reality the project that I am looking for to carry out I also want to apply it to my lifestyle because it is a product that I want to develop that I also thought about applying it to a user like me

- In the last semester, i didn't even think about using recycable materials for my project, and now it was the first I took in consideration

- By raising awareness and choosing materials, we also seek to replace materials with others.

- In the materials we are planning to use, do not leave a mark on the environment and be recyclable or reusable

- We also focus on product sustainability taking into account all the aspects that are needed from its creation to its end

- In my own lifestyle I try to ensure that these principles are present in all aspects, however, with respect to the project, it is the same as I commented in 1

- the truth since entering design has changed a lot my lifestyle and that of my family looking to minimize our carbon footprint with small actions

- the subjects of this semester have given me many tools which I can apply in my daily life

- It has helped me to become more aware but I do not apply it 100% in my life

- As the project does not have a sustainable approach, it does not impact your life and your actions so much

- Yes, I could say yes, in my habits and even in my work

- I think that it is more for the matter of prospective industrial design that changed my way of seeing and acting both in the application to design and in my life

- I have some information on the subject

- I don't want to do disposable things

- know new trends are applied to this project

- I am looking to develop an environmentally friendly product

- because since I have knowledge of sustainable development I try to apply it in my daily life
- I have known procedures to change plastics for different starches of vegetables with a process and environmental impact

- I am looking to develop an eco-efficient product / service

- In the way I see things in my day to day I always try to find a solution

- First, that nothing at the end of the class with a novel product that required me to improve my visual and manual skills

- It seems to me a very important issue for the environment although my projects still do not apply

- Nothing learned in this project has created a change

- In prototypes 2 we carry out various works with wood and material works and in the end nothing was used

- Yes, the use or use of resources is an example regarding the proper use and awareness of these

- We did not see sustainability issues

- The project is about breaking the paradigm that death is a bad thing and what happens to you for doing something bad, death is more than that

- I think that by attacking the current issue of the subject we consider these principles

- I used less and less disposable products and recycled cans and bottles

- We don't touch on the subject of sustainability in class this semester

- This semester I had no more knowledge about sustainable development because the subject was not focused on this topic

III. You are able to assess the life cycle of the product/s of your projects based on criteria that relate to the minimization of the multiple environmental impacts throughout the cycle.

- The choice of materials in my project was timely to have a durability of 5 years, allowing recycling.

- in fundamentals 2, being the first time, I did not know the operation of the materials, in projects now I know how to recognize them a little better

- It is of course sought, to improve the livelihood of products whether they last longer or that are biodegradable

- Yes, I am able to evaluate the products by the knowledge acquired in other classes.

- I know a little more about the product life cycle and initiatives such as cradle to cradle, however this was at the end of the race and I think it should be introduced from the beginning

- explanation of the impact of certain current design designs at cultural and / or ecological level

- I think we need knowledge to fully assess the impact, plus there are projects more focused on the concept than the serial development of an object

- yes, especially with this project, (an electronic device) which entails a special recycling process and as waste after its useful life

- We seek to give our project a long life and use materials that are easily recycled or disposed of without causing a negative impact.

- When developing my product I thought from the beginning to the end of the production of this

- Mainly not, because I'm just learning how materials work

- I have not yet thought about the great minimization of the impact that the life cycle of my product will have

- I would like to know more about this and not just someone who tell me that I need to look that on internet

- one part of my project, will come back to the soil, to grow seeds.

- yes, by means of a system we project the life time of a product and take it to maintenance for the corresponding replacement

- Yes, since we want to use recyclable or reusable materials

- besides the "agile" methodology I have not only sought to apply it in this matter but in daily
life and that would help me

- is in my next project development points

- I am currently exploring new ways and materials to get the results I want and optimize the material to use

- I believe that there are still things to learn but the basic and main thing I have already learned

- Projects seek to grow with the user who can use it longer and that physical and visual changes is not a factor to throw it away

- the life of use of the product is long in the project so this aspect is not taken into account so much

- It has been a little easier to evaluate the sustainability of the ideas we want to develop and know if we can continue with that idea or not

- I reiterate that thanks to previous semesters and the prospective matter but it was not an acquiring process

- I am not able but it is something that I already have in mind
- I'm still working on it

- both working in the classroom and interviewing always take into account that it does not affect the environment so much in terms of material because if it did not even work it would be wasted material

- I met new ways to give them a product life cycle through an emotional attachment of these

- the implementation of innovative technology and resources

- If I am capable and it seems necessary for the good of the planet

- Before I could not understand all the damage that the design process can have but I consider the use of materials from the production of mock ups to the final design

- In the use of materials and research in biodegradable products

- Based on research findings, I can sense the component life cycle

- My products do not meet the requirements to be ecofriendly

- Yes, from previous knowledge I know what materials are best suited for new projects

- In the matter of user-centered design, we carry out an investigation of global pollution at the beginning of the semester and, based on what we have learned, we carry out our project based on little contaminated materials

- It is still an aspect to improve

- I can do it because I know how to use the "Ces" audit

- Durable materials that have a long life cycle were chosen in this project

- For a better use of the product we rely on the life cycle so that there is a greater use and
circular economy

- Thinking of a truly recyclable product

- Sketches and mock-ups that served as first and second partial evaluation

- In the case of evaluating the product life cycle, it is still hard for me to know that I will reinforce it in a class in the next semester

- The methods to reach the final product were very different from the ones I had

IV. You encourage the rest of the group´s involvement in sustainable development when presenting your projects to the group.

- I motivate the group because it has given me the task of investigating and deepening a sustainable and complex issue.

- The whole group of classmates has given me ideas for the project I am developing
- I do not consider that they are involved in presenting my project, but because it is an issue that is seen and reviewed at the beginning

- we reuse prototype materials

- I feel that we hardly motivate ourselves, only in the final project

- Not really, usually the presentations do not deepen many on these issues

- when thinking about products whose function will last and not only solve a momentary need

- Not everything is so easy to relate to sustainable development if it encompasses these aspects that generate interest

- We hope that by introducing the product and mentioning the reasons why it is sustainable, others seek to get more involved with the issue.

- Always, I feel a responsibility to generate some awareness when choosing materials

- Home garden projects

- Yes, in fact this class has been the class that has been most involved in a project of mine and I really like it

- We still do not choose the material, but in the meantime, we hope it is of good choice, to carry out the knowledge and practices of the last semester

- not at all since the project still does not demonstrate the sustainable approach

- when presenting my project I have not focused on talking about these issues but on the functional part

- being very varied projects it is difficult for everyone to comply with sustainability aspects but I think we are all looking to create durable and functional products

- Yes, since it is something that matters a lot to me and I think it is very important to do something about it

- I could motivate my colleagues more, I need to achieve that impact on them

- The involvement of sustainable development depends on each individual since, as I mentioned earlier in this project, there is no special focus on the environment

- at the end of the class we have a few minutes to constructively criticize the project of others has helped me refine details

- I believe that as a generation we already have a lot of motivation to take care of the environment and it is always good to apply it to your project

- I try to incorporate it but it is not my priority

- I am motivated by this topic and I like to talk about it
- In the group I have not taken much into account but it will be something that I will consider when presenting my final proposal

- new trends are generated that everyone wants to follow

- I am looking to connect with the user, creating a link

- not 100%, I need to get more involved

- My proposal probably contains elements that take time to decompose

- I think my project gives a broader vision of what we can do to improve society

- One of my personal ambitions is to inspire people to give their best.

- My products not being sustainable design do not inspire

- In some occasions but it is not usually a main product

- If it is a question of considering or taking into account the materials that do not affect so much in terms of environmental impact

- Hope so

- Social welfare is encouraged

- Being a trending topic I think it happens with all the students

- You have not mentioned these points

- Since last semester I have felt more identified with carrying out sustainable design projects

- I consider that I did not acquire new knowledge

V. You look for and find knowledge inputs and expertise from other disciplines in order to meet the sustainability requirements that your project needs.

- For the project, I have used methodologies that I have learned in fundamentals and other subjects

- The set of knowledge seen in other design classes leads us to the design of sustainable products.

- Most products support generating less garbage.

- I feel that we have incorporated evidence from past semesters

- I always try to get involved in new knowledge of different areas, such as engineering, since my latest products have been focused on technology

- in this particular semester we have involved other disciplines but more to a technological approach than sustainable

- Yes, with the application of the SD principles and the useful life cycle of the product

- All the knowledge acquired throughout the career is necessary to achieve a truly sustainable product

- Yes, I use all the knowledge that I have acquired in the other classes to develop biodegradable products

- We need knowledge of engine operations, pumps, etc.

- Yes, I cannot specifically locate which disciplines but I certainly incorporate knowledge of other subjects

- yes, in some subjects such as math for design, we learned to optimize prototyping too

- Yes, since in the matter of language and meaning of the objects we review the objects for how to represent them visually

- Seeing sustainability issues in industrial prospective classes makes me think more about aspects that I want to incorporate into my product

- Yes, since it is something that we must apply in the various fields of our life

- we conduct research in different areas to make as complete as possible

- It is important to always take sustainability into account in any project since in this way you can develop a more ethical project

- I currently have a consulting class that has helped me distinguish difficulties before reaching the end

- as designers we have to do it the more design information we have and the better we know more creative things and refine the solution of the problems raised, I think this is more as a designer

- I don't have enough knowledge about it

- I have become more involved in these issues and I like to share

- Yes, since there is the program that helps them know what material could be used up to the cost of transportation. etc

- it is necessary that the project know materials, recycling, etc.

- because I always tried to apply knowledge of other subjects including sustainable development

- creating an eco friendly proposal is not a priority

- All my classes have to do with this project and I can combine everything

- This semester, what I applied most was my modeling knowledge in Maya

- I try to apply what I know to my project and thus have a broad overview of what has been observed.

- Yes, when asked, it is done

- We use computerized prototyping concepts

- Well, to achieve this, different materials are needed, in order to empathize and collect inf in a correct way
- Much, since the project involves engineering and it is sought that it has the best possible use for the user and that the product of its maximum

- In my industrial design prospective class we have seen green design, eco friendly, sustainable design are concepts that I have been gradually relating to my other subjects

- There is still a need to reinforce project matters since I don't remember being focused on carrying out a project with sustainable requirements

Professors reflections and comments

After applying the survey to the students and collating the responses, the inquirer interviewed the professors who taught the Design Project courses, as an initial validation of the research. They were requested their reflections and comments, and they were also asked to share (if they wished) the contents and any additional material related to sustainable development that they had used in their class. The results are shown below.

- Design Project 1. The professor considers that the issue of sustainability is central, urgent and priority today. In his opinion, the integration of this topic into project subjects should not imply any problem for any teacher

because it is a subject through which the teacher can focus on the problem situation to be solved and it can be subject to specific dynamics that allow acquisition of sustainability tools. "Future curricula should include it in a more structured way, there are professors who, because of their interest and disposition, integrate it, but it should not be optional." The professor posits that industrial design is the discipline that most contributes to fill the world with rubbish, and that is why we must teach our students how to generate more sustainable processes and products. "It can be integrated into the most critical competencies of systemic awareness that must change the way the industrial designer sees his work." The professor added that it also applies to the architect and digital artists, because what indirectly pollutes the world is the internet, due to the infrastructure required for you to play a game on your screen or watch the news. "We must create awareness in students that sometimes not designing another product is the best option".

- Design Project 2. The professor commented that the guidelines she established for the project at the beginning of the semester considered that students chose a sub-theme of the category "Health and well-being" within the UN Sustainable Development Goals (category 3). Students deeply investigated the meaning, requirements and implications of the selected category and analysed how to apply it to their product. The teacher also asked the students to study the "Cradle to cradle" philosophy and to apply its principles in their product, "they had to justify the environmental, social and economic issues of their project". The teacher proudly comments that one of the teams of students in her class won the "Final battle" competition, a contest that we do at the end of each semester on the Puebla campus where all the students present their final works on all project subjects; The best projects are awarded. When asked about whether she considered evaluation criteria related to sustainability in her subject, she commented that she did, because it was essential that students comply with the brief of category 3 of the UN Sustainable Development Goals, "the students had to demonstrate how they solved the problem identified". The professor works in government and

comments that at the government level the UN objectives are being taken into account also.

- Design Project 3. The professor in this course was the only one from all the Design and Architecture Project courses who rejected to be interviewed.

- Experiences Design II (Design Project 4). The teacher had me (the inquirer) as a guest in her class to present the topic on the “Living Product Challenge” certification, an international certification that “is an attempt to dramatically raise the bar from a paradigm where simply doing less harm is laudable to one in which we seek to be restorative, giving more than we take”. Beyond that, the professor confesses that she did not include it as a class topic or as an evaluation criterion, but she is open to do so for the following semester. When presenting the Online platform that is being done as a Novus project, she recommended that the presentations, links and material be very well classified in subjects so that it is really useful for teachers and students, that it is easy to find the required material.

- Products and Systems I (Design Project 5). The professor commented that in his class he did not cover the environmental issue but the social-economic issue, since the project was focused on the subject of the death: when a loved one receives the news of being in a terminal phase, their days are numbered. The students had the challenge of designing a product to make this process less difficult for the person's family, for example, one of the teams designed a device to save experiences and memories of the loved one, to feel their company in the subsequent. The teacher does find it feasible to also integrate the environmental axis into his class next semester and evaluation criteria that consider sustainability in the projects.

- Products and System II (Design Project 6). The teacher had me (the inquirer) as a guest in her class to talk about Sustainable Development in Product Design. I presented the topic on the “Living Product Challenge”

certification, an international certification that “is an attempt to dramatically raise the bar from a paradigm where simply doing less harm is laudable to one in which we seek to be restorative, giving more than we take”. Beyond that, the professor states that he gave his students total autonomy to implement sustainable development in their projects, his role was only that of facilitator and not that of expositor of contents in SD. This is because he believes that students should be responsible for this topic (it should be noted that they are students in the last year of the undergraduate). The professor comments that the group worked on a real project for the Steel Case company.

- Professional Insertion Project (Design Project 7). The teacher had me (the inquirer) as a guest in her class to talk about Sustainable Development in Product Design. I presented the topic on the “Living Product Challenge” certification. The teacher explains to his students how to sell his projects, how to present his pitch and other topics of great importance taking into account that they are students in his last semester of the undergraduate's degree. The projects were very focused on the business issue, the environmental issue was not deepened, only the social-economic part was reviewed as the projects sought to improve the quality of life of users. The professor adds that in his opinion it is difficult to talk about SD, for him ‘it is ambiguous because it is very broad and it is not clear what is really sustainable’.

Architecture Programme

1. Survey Results

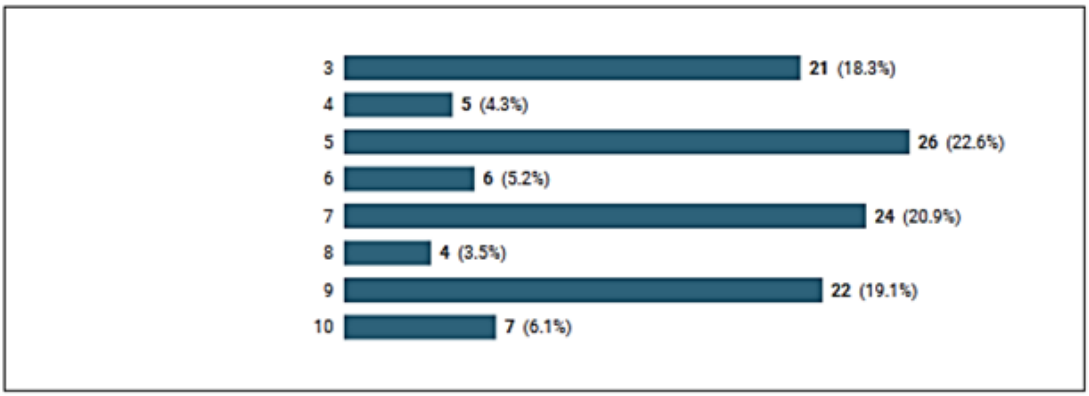
A total of 164 students were enrolled to an Architecture Project course for the August-December 2019 semester at the Puebla campus of Tecnologico de Monterrey. 70% of them (114 students) answered the survey.

The Design Project courses comprise the following subjects:

- Project 1: 26 out of 37 students participated (70%).
- Project 2: 17 out of 23 students participated (74%).
- Project 3: 9 out of 14 students participated (64%).
- Project 4: 19 out of 19 students participated (100%).
- Project 5: 14 out of 24 students participated (58%).
- Capstone Project I: 7 out of 12 students participated (58%).
- Capstone Project II: 15 out of 21 students participate (71%).
- Final Project: 8 out of 14 students participate (57%).

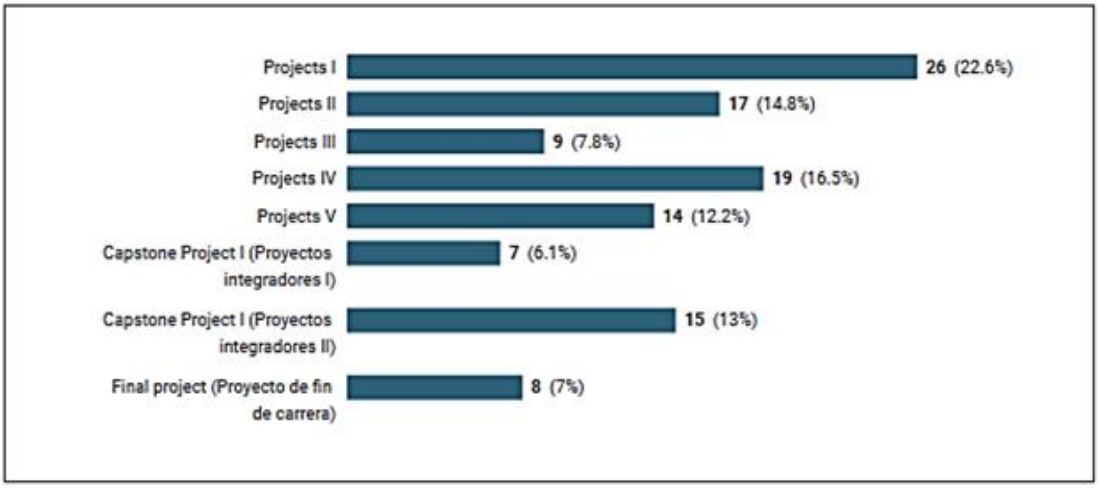
Demographic information of the survey:

IV. Semester in which the participants are enrolled:



V. Gender:

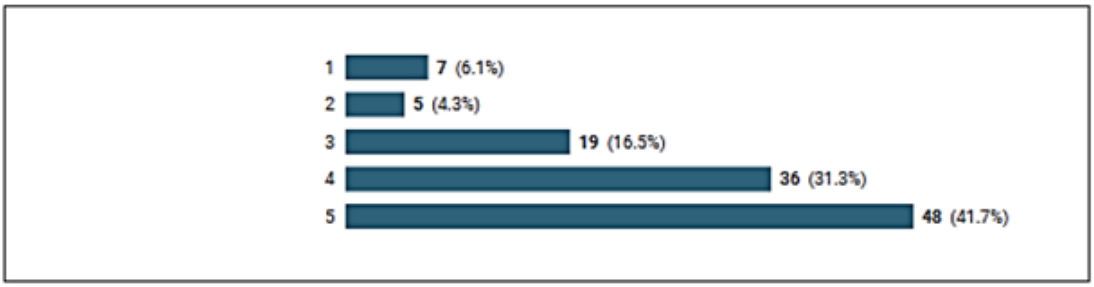
VI. Subject:



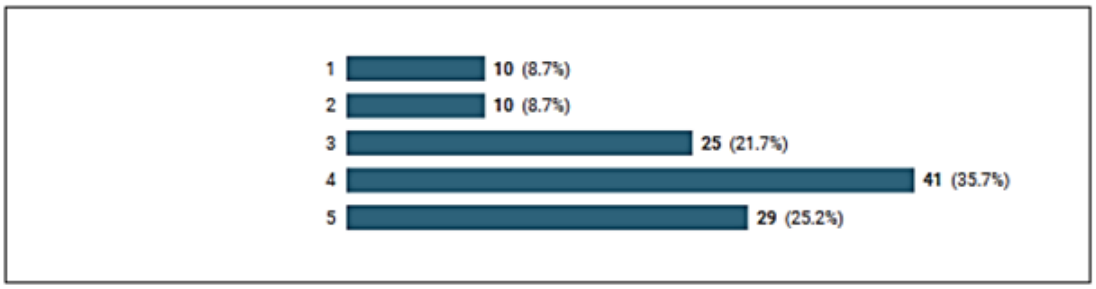
*Note: The percentages at the beginning of the document represent the total number of students who participated for each subject. In this table, however, what is shown is the percentage of participants that belongs to each subject, of the total number of participants.

The following tables show the results of the participants' responses to the questions of the survey. The numbers 1 to 5 are where 1 means LOW and 5 means HIGH.

1. How much did you find the projects carried out in the Design Project subject this semester, challenging and inspiring? Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.



2. How much did you find the projects carried out in the Design Project subject in the previous semester, challenging and inspiring? Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.

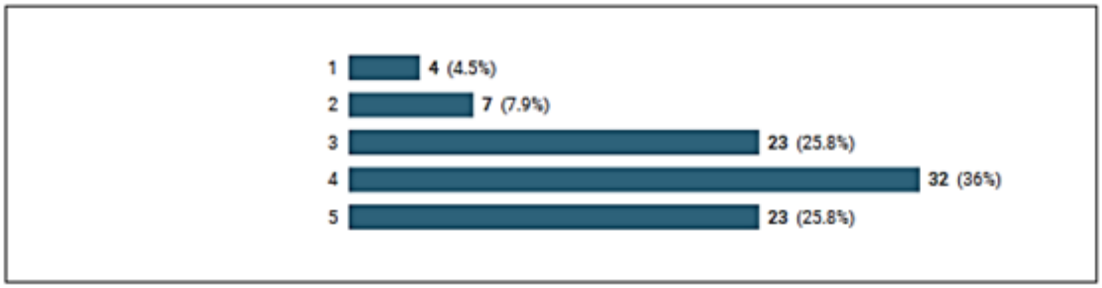


The following tables show the results of the participants' responses to the questions of the survey in
relation to the development of Sustainability Competencies. The numbers 1 to 5 are where 1 means LOW and 5 means HIGH.

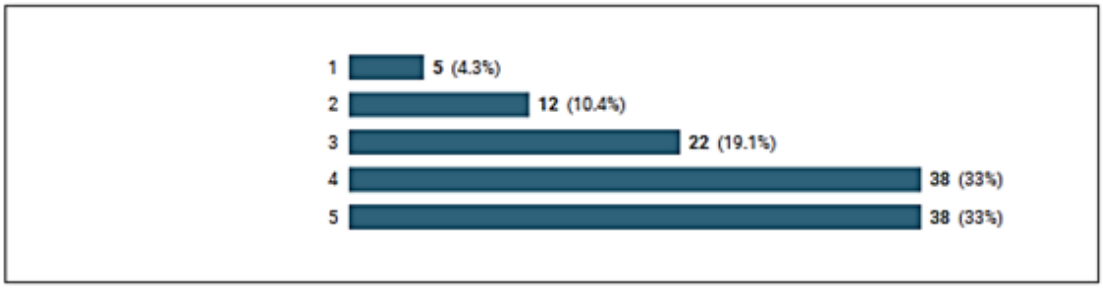
3. How much did you develop the following competencies this year? Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH. Should this be inserted here?

I. Your work demonstrates knowledge and understanding of sustainable development issues locally/globally. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.

January-May 2019 Semester (previous semester):

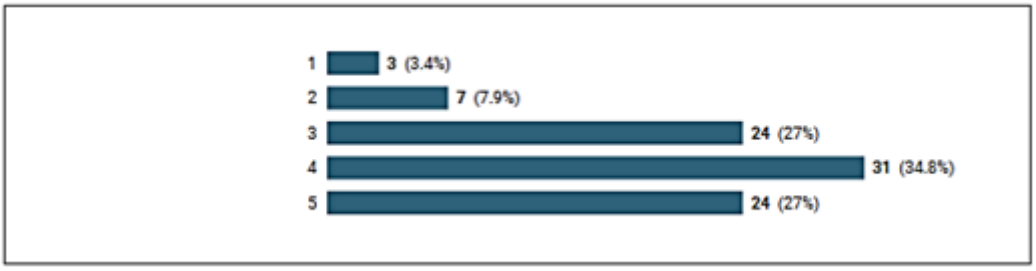


August-December 2019 Semester (current semester):

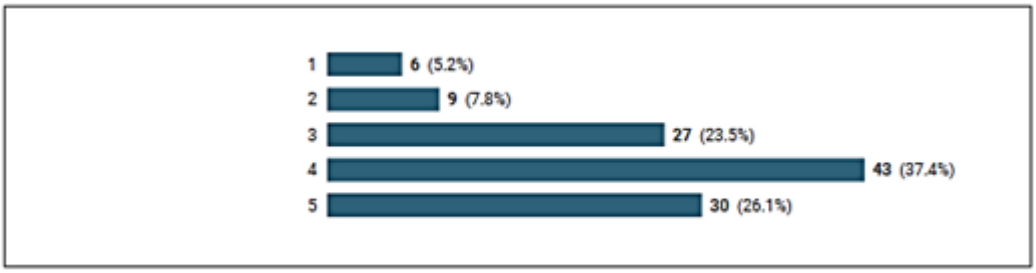


II. Your work demonstrates a mind-set change in relation to sustainable development through the successful minimization of the multiple environmental impacts throughout the cycle. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH.

January-May 2019 Semester (previous semester):

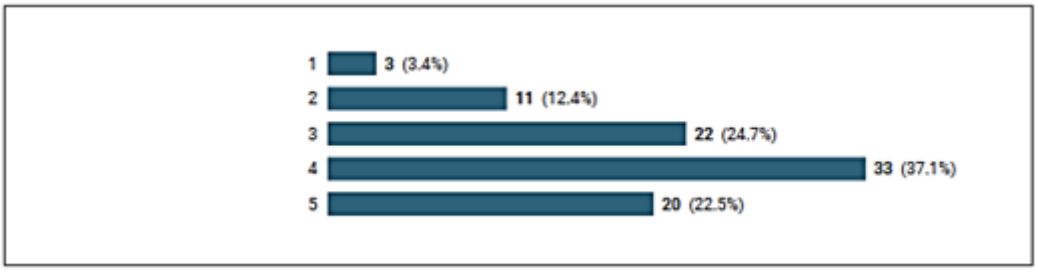


August-December 2019 Semester (current semester):

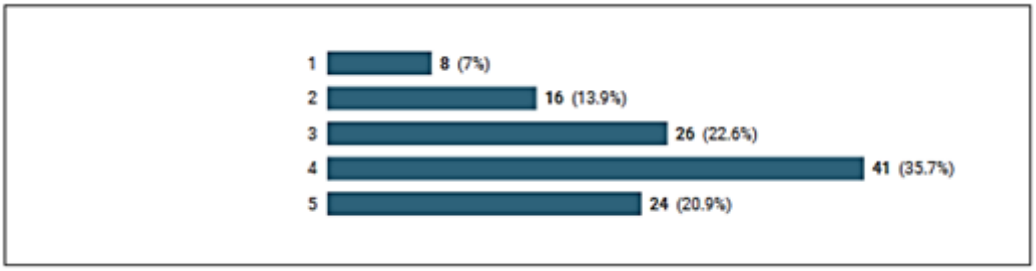


III. You are able to assess the life cycle of the product/s of your projects based on criteria that relate to the minimization of the multiple environmental impacts throughout the cycle. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH

January-May 2019 Semester (previous semester):

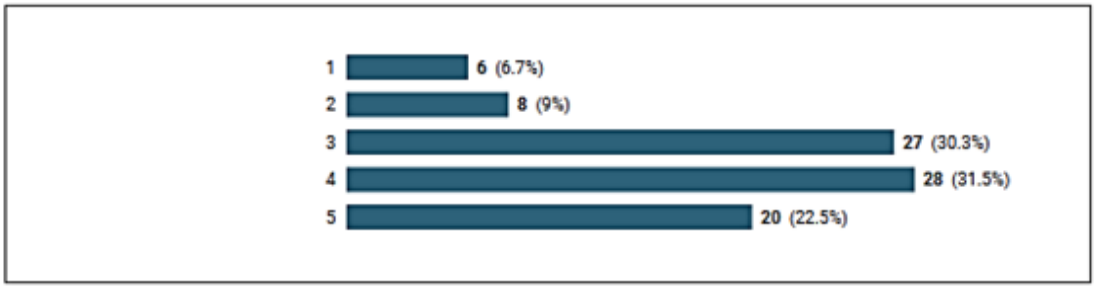


August-December 2019 Semester (current semester):

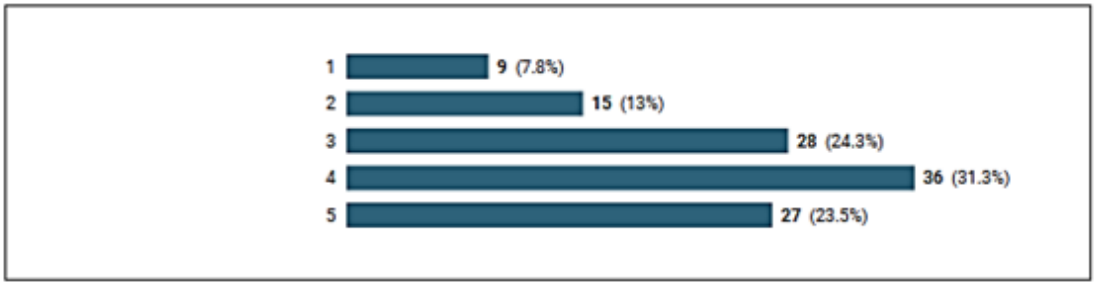


IV. You encourage the rest of the group´s involvement in sustainable development when presenting your projects to the group. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH

January-May 2019 Semester (previous semester):

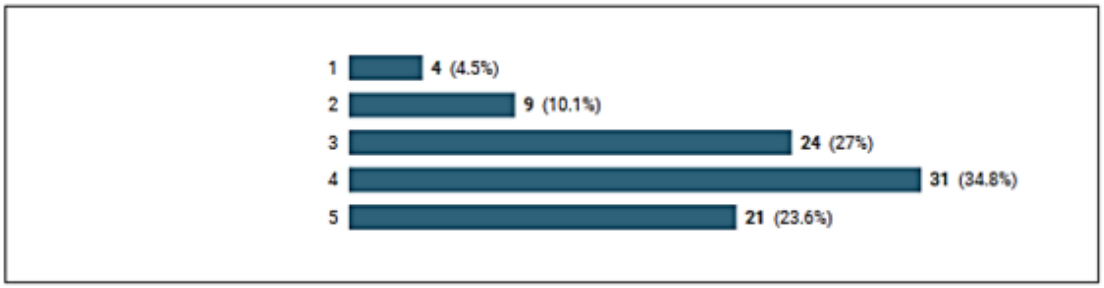


August-December 2019 semester (current semester):

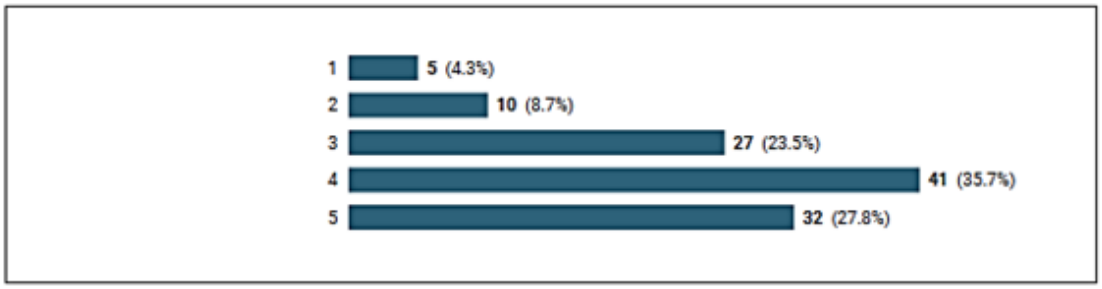


V. You look for and find knowledge inputs and expertise from other disciplines in order to meet the sustainability requirements that your project needs. Evaluate from 1 to 5, where 1 means LOW and 5 means HIGH

January-May 2019 Semester (previous semester):



August-December 2019 semester (current semester):



The next section presents the written comments that the participants provided to support their selection of each of the competencies scores. As explained before, this was considered relevant to ensure that the students selected the most accurate value in the survey and that they reflected on the competencies that they developed.

I. Your work demonstrates knowledge and understanding of sustainable development issues locally/globally.

- We have a lot of background

- We are working towards a project that requires environmental consciousness

- We had to search for information about bioclimatical technologies
- High development during both subjects
- We were asked to think in a sustainable way
- No sustainable development involvement
- Not really
- My work was wonderful
- using bioclimatic design
- This semester we have been through some global issues of environmental character that reflects in the designing process
- I don´t understand the importance of concepts in architecture, everything seems very confusing and unclear
- The project we are working on is not sustainable by itself
- Use of sustainable material, passive architecture systems to address climate change
- We need more theoretical classes
- In each project I consider my architecture to be green
- Water collection, cost reduction in expansions

- Thanks to the demographic and social analysis of the project, we were able to come to an understanding of why there were no sustainable cycles and how we could propose an action plan.

- We proposed a sustainable project in the second part

- A design proposal with ecological and sustainability criteria was proposed as the basis for the training partner in the mid-term review, which was rejected by the client.

- Thermal comfort and orientation of the building

- Making a bioclimatic house and analysing examples like mud house

- We had an internal garden that helped reduce bad smells due to the Atoyac River

- The project is based mainly on sustainability and alternatives that are friendly to the environment.

- We seek to implement urban strategies that are sustainable.

- The course has not met expectations

- It has been a very complicated project but we have worked hard due to the complexity of the project
- we have not seen any sustainability issue

- Projects have always sought to be socially responsible, although we do not have high-tech strategies, we are aware that the quality of life and representation of the user is always considered.

- The projects are based on real events, however, it is not specifically required to propose bioclimatic solutions or based on sustainable development, it is rather intuitive in the solution of the project
- Climate aspects were taken into account, for the improvement of micro climates, but no more

- Throughout the semester we were seeing criteria on concepts and design, instead of covering constructive or bioclimatic topics

- No project within the subjects of projects has made us demonstrate our skills in the subject of sustainability. The teachers here simply teach us that the projects are functional and / or have a concept.

- With the project we are trying to support some of the points of the sustainable development agenda, such as poverty, land use and especially decent work and economic growth

- Because it is important for knowledge

- During my courses I tried to implement and understand sustainability in each of my projects.

- Currently we do not have a project where we can focus 100 percent on the sustainable issue since they are buildings protected by inah

- During the semester I did not carry any subject related to sustainability; it was simply constructive introduction

- I think that in the matter I learned more things about architecture, they were details that I didn't take into account before, I liked that we were doing different things every time and with a higher level of complicity

- Throughout the semester the requirement was quite a lot, so the work and activities in class should be carried out with time and dedication

- During the semester I had the opportunity to analyse the sun's trajectories and its prevailing winds at different times of the year.

- I learned to be able to locate sunsets, places that require heat, sustainable materials, hermetic materials for construction, to apply both vertical and horizontal eaves, among many other things that throughout this semester, for the subject of bioclimatic design and projects. It has served a lot.

- In the last case we study the climate of Puebla to be able to present a bioclimatic design

- It is challenging, and interesting. The projects could be more personal.

- Everything that I have learned since I arrived at the University has served me and I believe that the subjects that I have taken per semester have been in an excellent order.

- Why do you work thinking about materials in the area or are construction and architectural techniques recognized?

- I have learned a lot with Master Sanuy

- We always try to propose materials from the area in order to help nearby people being all local

- I have learned a lot, and I really enjoyed the class

- The subject of the project was not sustainability

- We are not designing focused on sustainability

- The previous semester the competition and the knowledge obtained was good, since even several external professors and experts came to give us talks

- When we were designing a project in a real space we were thoroughly investigating what is happening in the place

- We were working on a real case where with our knowledge we gave solutions according to the problems that residents indicated to us

- Our work is based on community problems, however sometimes we offer sustainable options to make projects more enjoyable and economical.

II. Your work demonstrates a mind-set change in relation to sustainable development through the successful minimization of the multiple environmental impacts throughout the cycle.

- We need to read more references and have the teacher explain them

- Water collection and green areas

- We proposed to minimise the impact that would have on the proposed site

- Change the type of materiality depending on the orientation and function of the room

- We try to put gardens to recover the built space

- Yes, since in our case we look for transport alternatives and propose non-motorized transport.

- Within the strategies is a 100% pedestrian circuit, tactical urban planning with sustainable material, etc. because we haven't touched on any sustainability issue

- I do not feel a significant change regarding sustainable development, however I am not unaware of our responsibility as builders

- I believe that more emphasis needs to be placed on sustainable development issues in our projects

- We look for ways to get energy from the sun to achieve our project

- We don't really focus the design on bioclimatic systems, or maybe we do but in the end

- No project within the subjects of projects has made us demonstrate our skills in the subject of sustainability.

- The teachers here simply teach us that the projects are functional and / or have a concept.

- If I have implemented but I have lacked to exploit 100% the knowledge learned.

- Our project does not focus on that topic

- In Fundamentals of Design we talk about hybrid structures that help the consumption of concrete, which is one of the most polluting materials.

- Yes because it is important for learning

- The subject of Bioclimatic Design helped me find new strategies when designing a project

- We demanded a lot from the sustainable part, that we take into account that what we are studying has a high impact on the environment

- We learned to choose materials that were compatible with the environment and where they should be used.

- I have learned various methods to reach thermal comfort that have improved over the semester, you can see in my deliveries of the first part and the second part.

- we go a little further to biodesign in Puebla

- Every semester I have matured and helped me for my projects

- Natural influences are recognized to put them in favor of architecture and thus help the environment

- Not much we just do in the area of materials

- I have learned to collaborate with communities

- We are not designing focused on sustainability

- The way to develop the project last semester was green because the project was practically in a location isolated from services.

- Through constant research and being attached to reality my way of thinking, having projects attached to reality you can know more about what the place needs

- Of course, we thought about making the minimum possible climate intervention. I mean work without cutting down trees, without much digging, and others.

- Yes, we look for ways to support the projects.

III. You are able to assess the life cycle of the product/s of your projects based on criteria that relate to the minimization of the multiple environmental impacts throughout the cycle.

- Still need to work in that

- We were asked to think in green strategies

- We will include it

- I think I need more information in that specific field.

- I was able to do it

- Yes, as I wrote in the previous question, we use local material with long live and with low impact in the environment

- Construction materials such as concrete have a longer life but their decomposition and reuse is minimal and with great damage when used if it is not a material that is accessible

- If acceptance is achieved, the project can last for many years and more alternatives can be implemented.

- It is still in the prototype stage and final choice of materials
- because we haven't considered any sustainability issue
- We have not investigated much of the subject
- We do not know how to apply it
- No project within the subjects of projects has made us demonstrate our skills in the subject of sustainability.
- The teachers here simply teach us that the projects are functional and / or have a concept.
- Mostly not because the projects have not focused entirely on the sustainable part
- There is a possibility but we do not address it completely
- I could make the relationship between what we were doing and the minimization of impact, but in class we didn't really deepen it.
- It is important for learning
- Yes, you really realize how much you can contaminate and in what ways you can help the environment
- We were explaining in detail how the projects work
- We do not go deeper into this topic.

- As a group we have learned to contribute ideas and various application methods to create a sustainable and sustainable design.

- we only apply bioclimatic strategies in the last project

- I think they have to teach me more about the types of materials that can be used

- The properties of the materials and their life time are known

- We are not designing focused on sustainability

- Many of the projects that were used as an example and inspiration were projects based on sustainable construction

- I am more aware of what it can affect in daily life

- What do we think about the durability of materials?

- Many times we are aware of what we use in our projects and the idea is that they are durable for the community depending on their location.

IV. You encourage the rest of the group´s involvement in sustainable development when presenting your projects to the group.

- We encourage to create green ideas

- Each one does what they can with how sustainable the project can be

- We try to educate by our project, using it as an example that we can make a change

- We find new technologies so they can have more interest in the subject.
- We need to improve that part
- I believe that if we as individuals start to do some changes we´ll do a great impact as a community
- using bioclimatic design
- I think all the projects involve sustainability
- Not really, the majority of the students in my group are not interested
- Concise and understandable information was missing
- No, since we did not learn it in class but we are required to consider it
- Feedback from the external partner told us that this was not the path they were looking for.
- Propose a water withdrawal to minimize service costs
- Yes, in each proposal that my team and I put forward we seek that it be in favour of sustainability.
- The challenge is that a sustainable method is used in each strategy
- because we haven't considered any sustainability issue
- It is not a topic we discuss
- Not really, almost all feedbacks are architectural

- No project within the subjects of projects has made us demonstrate our skills in the subject of sustainability.

- The teachers here simply teach us that the projects are functional and / or have a concept.

- I still lack motivation

- None of the partners have this issue in mind in a complete way

- We didn't talk much between classmates during class.

- It is important for learning
- I think I always try to take the outside into account when creating a project.

- Many students in the classroom did not take into account this issue, it was seen as a requirement for the grades. But I am sure that many others did seek to inform ourselves well on it.

- In my final project we had to apply different vernacular techniques which were through everyone's participation.

- I have proposed ideas that have taken an important turn to various projects, I am active when it comes to bioclimatic design and also applying my knowledge that I have learned in class.

- it's something we all take into account

- Not much

- There is very good feedback from the whole group.

- We are not designing focused on sustainability

- Virtually everyone in the group had the need to work with green materials and self-construction

- Every time someone proposes something new, the advantages and disadvantages are seen because it is known how it can affect

- We always comment on our ideas before the group.

V. You look for and find knowledge inputs and expertise from other disciplines in order to meet the sustainability requirements that your project needs.

- We always take in consideration the green basis

- We try to create a very complete project

- I look for them, but when discussing with the team it becomes harder and difficult to convince the to include them

- I think that if we talk about sustainability there are other fields involved besides architecture, so the more you know, the better.

- Depends on the project i could use different disciplines

- using bioclimatic design

- Biology is a great source of learning.

- in my opinion my teacher helped us so that our project had a good environmental reach

- Classes focused entirely on the sustainable

- Thanks for joining me

- We researched and learned a lot when making our proposal for the second part.

- We require the knowledge of an engineer to perform calculations of water occupation

- Yes, with engineers, marketers, industrial designers, etc.

- because we haven't talked about any sustainability issue

- I have searched little about it

- Yes, because the subject catches my attention
- No project within the subjects of projects has made us demonstrate our skills in the subject of sustainability. The teachers here simply teach us that the projects are functional and / or have a concept.

- I will try to implement them even more

- We approach different bioclimatic situations but not enough

- How sustainability was not a criterion in the classes, I was not looking for external sources to support my projects in terms of bioclimatic decisions.

- It is important for learning

- Yes, I am always looking for ways to connect the subjects I am studying

- If I wanted to know or have a greater impact on the environment, what I did was ask my teachers and they recommended me some books or pages

- On the subject you can only have as a reference my bioclimatic design class. On the other hand, also a bit of my history teacher.

- It is important to know these terms to make a place comfortable and sustainable over time

- we really have to investigate more because the matter itself is not biodesign

- Knowledge can be shared and applied in projects

- We are not designing focused on sustainability

- We had the opportunity to have sustainability experts, although they could have been more

- It is good to rely on other subjects that complement us to the design of our projects

- I like to inform myself and find new technologies that help the environment. I think it is interesting.

Professors reflections and comments

After applying the survey to the students and collating the responses, the inquirer interviewed the professors who taught the Architecture Project courses, as a validation process. They were requested their reflections and comments, and they were also asked to share (if they wished) the contents and any additional material related to sustainable development that they had used in their class. The results are shown below.

Project 1. This semester we had two groups of Project 1:

Group 1. The teacher explained that she gave her students an introduction on sustainable architecture, starting from the meaning of the concept and the difference between sustainability and sustainability (she explained that sustainability covers the 3 axes: economic, social and environmental). She told them about the repercussions that the concept has on architecture and about the importance of choosing materials in terms of housing durability, adaptability and other values. She stressed that they should not choose a material just because it is striking or fashionable, they must reflect where the material comes from, how it was produced and shipped, as well as how is its implementation. There are some materials that are attractive, but not very durable (affecting the economic and environmental axes). She also generated a class discussion on this topic. In one class they went to the library and the manager taught them how to find bibliographic collections of sustainability in architecture. For the class challenge, which lasted 2 weeks (designing a shelter / cabin) the students had to apply notions of sustainable architecture and reflect on the material use of the context to reduce transportation costs and not to alter the environment. She also emphasized in class the importance of thermal insulation considering natural methods without impact on the environment (for example, they talked about a type of wool that is very expensive at the beginning, but in the long term it is compensated for its great durability and thermal capabilities). She also told them about thermal, acoustic and lighting comfort. In total she dedicated 3 classes to the subject and an

exercise in which sustainability was a requirement. However, she confesses that she did not put sustainability as an evaluation criterion for the subject.

Group 2. The teacher of this group asked the students at the beginning of the semester to read two relevant texts on the theme of sustainability: "Basic Sustainability Guide by Bryan Edward" and "Barefoot Architect's Manual". In the opinion of the teacher, although the official program of the subject does not mark it, the issue of sustainability is a must and with the help of these readings the students understood the subject more. "Sustainability is closely linked to the issue of facilities and construction issues, not linked to the part of architectural design." The professor commented that he linked his subject a lot with the bioclimatic design subject that the students take in the same semester. He asked the students to justify the shape of their design with respect to the location, that is, he asked them to investigate the climatic data of Puebla and then encouraged class discussions on how to apply these data and make decisions regarding the shape and function of the space (for example double walls, use of ruffles, use of glass, orientation of the house considering the sunning and others). The students learned about the sun charts and what are the most critical days of the year in Puebla; they learned about how the shape of the space can contribute to the economy of the user. He considers that he failed to address the social and economic issue, as he focused more on the environmental issue. He encouraged students to connect knowledge with other subjects.

- Project 2: When interviewed, the professor commented that she decided that instead of teaching issues about sustainability to the students, or asking them to read some material, she decided to send them to a fair on renewable energy that took place at the beginning of the semester on the Puebla campus. She asked the students to investigate which products and solutions they found most interesting and which of them they could implement or apply in their projects. They had a class discussion about what each student found. When the professor was asked her opinion on the experience applying

these concepts even when the official curricula did not consider it, she said that she was happy to do so and the she will be willing to do it again because she considers it a very relevant issue.

- Project 3: When the teacher was asked about her experience including sustainability content in her class, she replied that it was not difficult and that she would do it again, “I think it was simple and that it should be something obligatory to generate in the students a complete vision of architecture and to generate innovation”. In addition, she stated that it should be a mandatory topic to be included in all projects courses, "in the undergraduate there should be a gradual advance in the issue of sustainability, so that students apply it in their professional life." She also commented that she asked her students to attend all the conferences in the campus this semester in relation to the issue of sustainability, she added that it was a requirement to go to the conferences and to submit a report. Additionally, each project presented by the students had to include sustainability proposals based on at least five different authors (five bibliography sources), and they made bibliographic records to apply it in future projects. When the teacher was asked if she included sustainability evaluation criteria, she commented that sustainability did have value in one delivery, but in others she did not consider it. She plans to include it next semester as an evaluation criterion. When he was explained about the Novus project that is being developed (the online space), she suggested that the presentations and readings be ordered by semester, with a clear order to prevent teachers from repeating topics and so that there can be a guaranteed gradual progress for students throughout the undergraduate.

- Project 4: “Not being an expert in the area of sustainable development, it has been difficult for me to be able to develop some content in depth in relation to the architectural project. Therefore, I suggest supporting the subject of Projects IV and mainly the development of projects, with expert agents in the area of sustainable development: from the approach and conceptualization

of the project, reflecting on the social and urban, as well as the same formal, technical solutions and structural of the space proposal".
"Being an area of high complexity, it is not always easy to develop and evaluate in a successful way the contribution of projects to this field. It would be interesting and pertinent to be able to agree on a rubric for the evaluation of minimums that allow defining objectives and consolidating in the student the main contents that should be considered in an architectural proposal".

- Project 5: A part of the Project sought that students justify the material selection decisions according to the sustainability of the material. He asked his students to investigate the recyclability, thermal conduction, thermal efficiency, durability and toxicity of different materials and to make a comparison between materials in order to choose the most efficient and suitable for the project. Then they had a class discussion about how to promote sustainable cycles from public space to architecture, designing an interaction between users and the built environment with a specific function that would encourage natural cycles: urban gardens, water regulating vessels (lakes where concentrate water runoff from a housing unit, through slopes of streets and drains operating independently of the drainage). The teacher feels that students do like the subject but also that they are not used to it being a requirement, they see it as optional when in reality it is not, but goes hand in hand with design. She sees it viable to continue to include SD in her class and she would do it again because in her opinion it greatly enriches the vision of design and she is aware of the power of the architect to promote sustainable cycles. She recommends emphasizing that it is not a separate issue, but that it is an integral part of the architectural design.

- Capstone Project I: The professor of this subject considers that in general his experience adding sustainability content was good, they worked on a real project ("El Alto") and focused on solving the urban issue and public space. His students proposed the recovery of rainwater in the area for the

benefit of the neighborhood, they proposed that all streets have endemic vegetation and proposed non-motorized mobility strategies. The students sought to reactivate the economy of the neighborhood more evenly and not only in certain areas, they emphasized encouraging local commerce and in general the local economy. The teacher is open to include the sustainable theme again next semester, as he believes that the issue of sustainability should be handled not as an aggregate but as the central axis of the projects. He plans for the next semester to invite an expert on the subject of water to his classes.

- Capstone Project II: The professor states that in general, the student considers the sustainable development of the project as a “plus”; that is, something that is not mandatory but that adds value to the project. He states that it is necessary that both teachers and students understand that this attribute is a fundamental and inseparable part of any space proposal that wants to be raised, not a complement or addition. He posits that it is important to start with the discussion and reflection from the initial projects and that it would also be appropriate for students to study specialized subjects in this area from the initial semesters or the 1st half of the curriculum to be able to apply content and strategies throughout the development of the different project and / or urban subjects. He recommends to accompany the creative process and technical solution with experts in Sustainable Development who could “coach” teachers and students from different points of view: production, management, construction, design, social, implementation, etc.

- Final Project: The professor explains that in this area the project was closely linked to environmental issues, they worked on a real project for “Grupo Xcaret”. He comments that in his opinion it is very difficult to convert a project to be sustainable if it was not contemplated from the beginning. He also comments that he invited a teacher from another campus to one of the initial sessions of his class, and the professor judged the project as an “ecosidium” (ecological suicide) because it is a project in which the company

builds in natural reserves of the Mayan Riviera. However, the professor who is responsible for the class (the one who was interviewed) explained to the students that economic and social issues should also be considered, because the company is a great source of employment and that it is also responsible and performs regeneration of other land to compensate the land they are taking for their projects. In his opinion, the project is viable for society. He also commented that his subject is in the last semester and that he recommends that the topic be seen from the first semesters so that when they reach the end of their studies, students really see the sustainable issue as something of great importance and that they understand that it is not only an environmental problem but a social and economic one. Finally, he commented that he promoted class discussions on this topic and from an open perspective and a critical vision, integrating the knowledge learned in the subject of Bioclimatic Design.

G1.3. Curriculum Inquiry Cycle 3 Focus Groups

G1.3.1. Summary record of results of the focus group with students

The tables below (G3.1.1 to G3.1.4.) present the questions and findings from the data collected from the focus groups with students. The code CI (curriculum intervention) identifies the responses from the students who had participated in the curriculum interventions, which included sustainable development content and competencies. The code SC (standard curriculum) identifies the students who had not participated in the curriculum interventions. A number follows these codes. This identifies the semester that the student was in at the time.

G3.1.1. Question 1	
G3.1.1.1	Have you learnt anything about sustainable development in the last three semesters?
G3.1.1.2	If you have learnt something, what have you learnt? In which subjects did you learn about sustainable development?

G3.1.1.3	Who was involved and what contexts did the learning take place?
G3.1.1.4	Can you say what it was that made a difference to how you think about sustainable development in relation to design practice?

Student responses to Question 1	
CI.7	I learned about the product life cycle. The design professors of that semester guided us on this topic.
CI.7	The professor (A) taught us about green design and eco-design. I think that sustainability is an issue that should no longer be optional. Emphasis was placed on projects for the environment and on materials which were not harmful.
CI.8	In the subjects with professor (A) we learned about sustainability.
CI.8	Professor A reaffirms the subject of sustainability in her classes. Also, in the project (Design of Products and Systems 1), with Professor B we made a project for the Atoyac River. We learned about the impact that the river is having and to think about the future of the product that we designed: what will happen to the product when its useful life ends.
SC.9	In normal classes I have not learned about sustainability, only in the subject: 'Planning, Innovation and Strategic Sustainability', which is in the business area.
SC.9	In the class of Planning, innovation and strategic sustainability, which is not on design, but on the business area, I learned the difference between 'Sustentable' and 'Sostenible'. I feel that the sustainability is an issue that the design teachers are requiring from us in the project classes, but they don't explain how to achieve it.

G3.1.2. Question 2
Can you give examples of projects through which you applied what you had learnt or began to think about how you could do this?

Student responses to Question 2	
CI.7	We learned more about sustainability than in the other semesters. In the Fall semester (August-December 2019), we made structures for the reforestation of coral reefs. In my team we developed a type of cement that is not harmful to the environment. It is made of natural ingredients and waste materials that are not currently being re-used: fly ash (which is a waste from the electrical industry), glass sand (we allied with a beer company that gave us empty glass bottles to crush them and to make sand with nutrients for corals), and volcanic ash (which is very abundant in this area of Mexico). We found that in Mexico there is no glass recycling. We also developed a collection campaign to encourage people to recycle and to raise awareness of the importance of caring for the environment. We have learned it because the professors in the subjects of Projects demand it.
CI.8	In the subject of Project Design of Experiences I, with Professor C, we were asked to participate in the Students Design Awards Competition organised by the Royal Society of Arts. All categories of the competition promoted a circular economy and sustainable development. These forced us to investigate these issues because we didn't know them.
CI.7	In the 'Products and Systems Design 1' class with Professor B, we were set a project focused on creating a device to measure the pollution levels of the Atoyac. The professor asked us to think about how the device could have parts that could be easily replaced, so that it would not a disposable product.

G3.1.3. Question 3	
G3.1.3.1	What do you think you can apply in your practice as a designer - that is different from how you thought about design practice before the last three semesters?
G3.1.3.2	What do you imagine this research can lead to?
G3.1.3.3	Do you think it could make a difference to how you think about design practice?

Student responses to Question 3	
SC.9	In the class of Fundamentals of Design II, we made a bulky product with a non-reusable material. The teachers didn't tell us what to do with it at the end of the semester. In the subjects “Prototypes 1” and “Models” we also generated a lot of waste. For example, from 'Trovicel', and there is no professor who motivated us to reuse the material or donate it. The janitors throw everything away at the end of the semester. It is not recycled. I think that homework should be designed so that in the end you can have it as a decoration at your house or something you can give as a gift, not something you have to throw away because it is useless.
SC.9	Design students use materials such as plaster, foams, resins and fiberglass that are harmful to our health and harmful to the environment. Teachers should ask us to look for alternative materials to reduce the environmental impact. For example, there are bioplastics made with fruit peels that can be cut with the laser cutter.
CI.8	Professor A promotes the design to assemble and disassemble: if the product is damaged you can repair it without generating garbage (she taught us about programmed obsolescence).

G3.1.4. Question 4: the online platform
We are creating an online platform to promote learning in sustainable development in design. What would you like to find there?

Student responses: the online platform	
CI.8	I would like to find material options that can be used and recycled, such as biomaterials and alternatives to plastic (bioplastics).
CI.7	A catalogue of materials with the prices and options for accessible prices for us.
CI.8	The teacher of the subject Computer Prototyping took us on a visit to Mexico City where we saw a catalogue of materials, but the environmentally friendly materials are very expensive and difficult to obtain. I suggest that

	TEC look for agreements for this topic and that we have access to that information on the website that is being designed.
SC.9	Information on what to do with the unused homework materials at TEC. For example, what to do with the pieces of foam, with the scraps of trovicel, which is not recyclable.
SC.9	People do not like to read. I suggest it is a very visual page and not saturated with many texts.
CI.7	That it is dynamic, that it includes infographics and audiovisual materials.
SC.9	That it has content on recycling that has learning purposes.
CI.8	That there is information on collection centres, for example, such as “ecolana” that are only available in Mexico City. Let people know where to take their batteries, bulbs, expired medicines, etc.
CI.7	How to reach people, with basic concepts
CI.8	That there are also resources for people who do want to learn more deeply and commit
CI.7	That there is a directory of companies and emerging sustainability projects because most of them are ideas and proposals generated by young people, students at TEC, biotechnology students.
SC.9	Offer incentives for people who recycle, for example, to offer movie tickets or a paypal card.
SC.9	That the teachers themselves can use the online platform so that they are the first to change their mindset toward sustainability. That teachers can promote in their classes that students enter the platform to find useful resources for their projects and information on sustainable materials for their prototypes.

Final Comments on the online platform

CI.8	A student asked if the online platform is a real ongoing project. The inquirer explained that the focus group, in addition to forming a part of the research, is also a part of a Novus project, which provides funds to develop the platform.
CI.7	A student recommended teaming up with professors interested in the subject to avoid isolated efforts: the impact will be greater when working as

	a team; sometimes there are several people working on the same or a similar project without knowing. This would save time and effort by working together. The student proposed an investigation into what else is already being done at TEC.

G1.3.2. Results of the focus group with professors

The tables below (G3.2.1. to G3.2.4) present the questions and findings from the data collected from the focus groups with professors. All the professors who participated in the focus groups participated in the curriculum interventions, integrating sustainable development content and competencies. The codes identify the responses from the professors who had participated in the curriculum interventions for the Design Bachelor (PD) and the Architecture bachelor (PA), which included sustainable development content and competencies. A number follows these codes to differentiate one PD or PA professor from another.

G3.2.1. Question 1	
G.3.2.1.1	Have you modified and / or introduced sustainable development curriculum content in your courses in the last three semesters? If you did modify and / or introduce new sustainable development curriculum content:
G.3.2.1.2.	Can you describe what this focussed on and the main reasons for this focus?
G.3.2.1.3.	In what subjects do you promote sustainable development learning?
G.3.2.1.4.	In what contexts did the learning take place?

Professor responses to Question 1	
PD.1	I teach Product and Service Design II and I taught the students about product life cycle analysis and 'cradle to cradle'. I asked the students to be aware of the impact of their products. No one knew the product life cycle analysis, despite being in the ninth semester. The students did know the UN sustainable development goals. I asked them to link their

	product to one or more of the goals and they all leaned towards the social context. The team that won in the final presentation of the semester proposed a system for collecting organic waste in markets, from collection, to transportation and handling, including the business model (economic axis of SD). I have also been teaching these subjects to 3rd semester students because they are not used to considering what will happen to their product. They propose without understanding the economic and environmental implications. They propose products and they do not realise that they are not economically feasible and feasible in general, and they forget that the main objective must be to solve a problem for the user. In another group we asked them to consider the objective of sustainable development related to water. The students had to solve a problem and they had to investigate water, pollution, water management by companies and other problems. It is very enriching to put these topics in classes (even if they are not officially considered in the curriculum) and to promote a mindset in the students. I show students the impact that their products can have.
PA.1	I think it was very positive that the request to include sustainability content and criteria in all Project courses came from the Director of the Department. I have seen a change in the last semesters. There is more awareness in the students, in the importance of designing, considering the following generations.
PA.2	We analyse the information of the projects with matrices and based on this, we ask the students to design their own indicators. We encourage students not only to keep good ideas, but to land them into reality. Selecting indicators from another context does not make you assertive because it is not focused on the real context of your project. We teach them how to design those indicators, so that they are measurable.
PA.3	When you add values (not just materials) to the resilience equation, you achieve a holistic concept.
PD.2	Who is going to train the teachers? I am missing a lot of these topics, I know little about the life cycle, what I know is from the economic side only because I learned that way.

G3.2.2. Question 2
Can you give examples of academic projects through which you promoted sustainable development centred learning and teaching?

Professor responses to Question 2	
PA.1	In Projects V, we are working on a project for INFONAVIT (National Institute of the Workers' Housing Fund). I promote that students solve the three axes of sustainability: social, environmental and economic. The one that costs them the most is the economic one, but I have seen a change in the students now that the sustainable theme in the subjects of projects has been reinforced.
PD.1	I believe that, as far as possible, students should be encouraged to develop real projects, linked to real external agents, because that increases students' motivation and commitment. It is also very useful for the external agent to evaluate and provide feedback to the students, that it is not only the teacher who carries out these activities.
PA.2	A colleague and I are teaching an energy efficiency class (for seventh semester Architecture students), and we are talking about certifications. We have asked the students to calculate their carbon footprint, because it is something that impresses them a lot. And we have asked them not to follow the guidelines of one or the other certification (in a decontextualized way), but we have asked them to establish their own sustainability indicators that consider the social, economic and environmental aspects. We promote vernacular architecture, local sourcing and local labour. Certifications often apply to large buildings and to other global contexts. That is why we give students the openness that they make their own indicators and goals for smaller projects, housing, etc.

G3.2.3 Question 3	
G.3.2.3.1	What do you think your students can apply in their practice now, that is different from how it was applied before the last three semesters?

G.3.2.3.2.	What do you think this research can lead to?
G.3.2.3.3.	Do you think it could make a difference to how students and teachers think about educational practice and the practice of design?

Professor responses to Question 3	
PD.2	I studied Industrial Design at the Monterrey campus and at that time the projects were focused on products that were somewhat trivial, such as designing a bread toaster. In contrast, today, students design products where they take into account sustainability: social, environmental and economic, but they are still at the level of possibility, at the level of proposals of how things should be, at the academic level. They have not yet reached reality. As designers we still continue to focus more on form than on function. We need to focus more on the problem that you can solve. As teachers, we must look for the way in which the projects of the students are brought to reality, perhaps through making connections with companies, with the support of the private sector, so that the designs can really be brought to reality.
PA.2	Last semester, in the Projects course, I guided the students in a real project that consisted of designing a tourist park in Cancun for the company 'Grupo Xcaret'. I did not give them theoretical sustainability content because the project subjects are, in my opinion, more geared towards students applying knowledge and for debate and discussion. In a debate the students had to reflect on sustainability because the project involved building the tourist park in an area of Yucatan that is currently a jungle. The students were in the tenth semester and I noticed that they lacked a lot of knowledge and theoretical bases of sustainable development. I propose that before going directly to design you have this type of discussion and reflection with the students. If you are going to make a decision that affects the environment, think about whether it is worth it or not from a social and economic point of view.

G.3.2.4. Question 4.
We are creating an online platform to promote learning in sustainable development in design. What would you like to find there?

Professor responses: the online platform	
PA.2	It is a good that the online platform, to promote sustainable development and that will be open to students of design, architecture and art is developed. I suggest that there be a section where each semester, the best student projects are published, where sustainability has been developed from the social, environmental and economic aspects. This would serve so that we all know what others are doing at the School and as a bank of projects that can be a source of inspiration and ideas for others.
PD.1	It is a good idea for the online platform to have a bank of projects because it serves as a reference for the following generations of students. They can see what has worked, what has been addressed and how it was achieved. A bank of projects also serves to see the evolution that is taking place in these subjects, for students and teachers.
PD.2	From my perspective, the theoretical content is very important. There are many theories that oppose each other.
PD.1	It is good that the platform contains information on the application of real projects, but that the theoretical part is not left aside.
PA.1	Perhaps it could be a bank of projects with interspersed theoretical content, with a more holistic approach.
PA.3	There must be a balance between thinking and doing, hopefully this balance can be reflected in the online platform.
PA.2	Take advantage of the intermediate and final project exhibitions that are taking place on our campus, to promote spaces for reflection and conversation. Students can give ideas and feedback from the online platform. Podcasts.

G1.3.3. Results of the focus group with external guests

The tables below (G3.3.1 to G3.3.4.) present the questions and findings from the data collected from the focus groups with external guests.

G3.3.1. Questions 1	
G3.3.1.1	Do you consider sustainable development in your current professional life and work? If your answer to this question is yes:
G3.3.1.2	To what extent and in what ways is sustainable development important in your current life and work?
G3.3.1.3	What has made a difference to how you perceive the importance of sustainable development in relation to your work?

External guests' responses to Question 1	
EG.1	The circular economy is an important topic. In my work, in each project there is something that in some way is related to sustainable development. I work a lot in infrastructure in the Netherlands and what I see here in Mexico, is that an urgency is not yet perceived.
EG.2	These are issues that we do not take into account until it starts to affect us […] We have to change that mentality. […] That is why education is very important. In education programmes we must carry out a case detection. We could generate material that shows what can happen in the future if we continue with each unsustainable practice. […] Why don't we document the lessons learned from a project so that later when we are in a similar situation, we don't repeat the same mistakes? We must begin to change basic programmes, to create new cultures.
EG.3	Your culture will dictate your behaviour and the decisions you make. The concept of success must also be redefined. TEC promotes entrepreneurship. It is a hallmark of TEC. And within entrepreneurship, there is a new branch that is social entrepreneurship, which is dedicated to trying to solve social problems. We can follow the TEC paradigm of

	being an entrepreneur, and at the same time with a social approach that benefits society.
EG.4	[…] I agree that culture plays a very important role. We must change the mentality of past generations that do not take sustainability into account. Now we must worry about what we are going to leave to future generations.

G3.3.2 Questions 2	
G3.3.2.1	Do you promote sustainable development in your company?
G3.3.2.2	Can you give one or more examples of recent projects through which you and/or your company promoted sustainable development?

External guests' response to Question 2	
EG. 5	I am supporting the government in developing strategies and we are implementing sustainable development initiatives, but I see that there are many good intentions submerged in a sea of mediocrity because the government in Mexico is a very obsolete apparatus, with chronic problems that prevent the implementation of necessary policies. There are unaligned interests and a lack of knowledge that prevents solutions from being implemented correctly. Student activism and strength can make a big difference in business and government in direct and indirect ways. There may be ways to push the government to go in the right direction.

G3.3.3. Questions 3	
G3.3.3.1	Do you consider sustainable development in your personal life?
G3.3.3.2	To what extent and in what ways is sustainable development significant in your personal life and how does it relate, if it does relate, to your professional life and work?
G3.3.3.3	What has made a difference to how you perceive sustainable development?

External guests' response to Question 3	
EG.2	I involve sustainable development in my daily personal and work life because it is very important for me to be very consistent as I am a biologist with a Master's degree in sustainable development and climate change. For many years I have been aware of this problem. Sustainable development has to be lived on a daily basis. In my house, I recycle. I try to buy only organic products. I rarely use my car. I don't consume disposable products.
EG.1	I am very interested in promoting these topics in my students, so that they know the success stories, the benefits of being sustainable. We ask students to translate what they see into the context of their community. […] I agree that education is very important. At TEC there should be more activities and more examples for students to promote sustainability; bio-construction; climate change issues. These initiatives should be very visual so that students can appreciate the examples right there on campus; that the campus functions as a laboratory where those examples are developed and that students can then replicate them in a real context, would be very enriching for them.

G3.3.4. Questions 4	
G3.3.4.1	What do you think design and architecture students can apply in their practice now, that is different from what they could apply in the past?
G3.3.4.2	What do you think this research can lead to?
G3.3.4.3	Do you think it could make a difference to how students and teachers think about the practice of design?

External guests' response to Question 4	
EG.6	I have seen that there has been a change of consciousness in the industrial designers that I hire, not so much that there is a change in the

	way of doing things, but at least they know about the UN Sustainable Development Goals and already consider environmental issues. The social issue is not yet embedded in the business environment. The economic one, it is considered because it is the predominant issue in any company. I have also seen that most of the actions by companies are not full of awareness about what sustainability means. They see it more as an environmental issue. For example, a company that wants to be "green" goes and pays to plant trees, when what it really should do is to rethink the business model taking into account environmental and social issues as well. There is still no vision of the critical need for sustainability.
EG.4	In my opinion, at a business level I believe that the main cause of the problem you have just discussed is that people do not even know what sustainable development is, personally I am in charge of social responsibility and we manage through a business foundation various projects, our company is on the environmental side, being sustainable has to do with the 17 SDG, within our projects we try to reach through education, that people really understand what is sustainable and that even by integrating sustainability you can continue to have a good business. What we do in addition to education, is at the business level: we try to impact together with our clients and strategic partners through projects focused not only on causing an environmental impact but also at the family level including children and parents. I think that our main reason that we have not made much progress on this issue is that we need to work mainly on understanding what sustainability is from the grassroots so that the solution is fundamental.
EG.7	On the subject of education, the concept of circular economy is very complicated. The government has to take the first step and provide a lot of support to companies. As for the universities, this semester I have 30 students, on average they are 22 years old and they will work around 40 years, if each year they could do 2 projects and put the issue of sustainability in them, those 30 people in 40 years would have made a big difference. It is like a puzzle where one piece is government, another piece is education, business, citizenship.
EG.5	More external experts should be invited to classes at the University because they are more aware of what is happening in the real workplace.

	There are students who present proposals that are supposed to be sustainable, but they only show renderings that are not really functional.
EG.1	I have learned that TEC is looking for the new teachers it hires to be working in the industry and have actual current experience. In my case, in the evaluations that the students do at the end of the semester, they mention a lot that the real examples that I give them of my work have been very useful to them, those are examples that can only be given being active in the labour market. We must teach students the theory applied to practice. In this, TEC has done a very good job, the teachers have work experience, it is also good what they are doing and the new TEC21 educational model where students work on real projects. What the student will remember is the presentation of his final project that he presented to the director of a real company or association and the feedback he received. If that director tells the student that what he or she is presenting will not work in reality, the impact and reflection is greater for the student than the impact of getting a bad grade on an exam. It is incredible that you still find people of all ages who think that the problem of climate change is an invented problem, that it is not true that it is happening. When you sensitise them, they understand why it is necessary to be sustainable and why the circular economy is necessary based on how nature works, in nature there is no waste: something comes from what previously died.
EG.3	It is not only necessary to promote links with companies but also with communities to promote empathy in students. It is necessary to question what development means. When students develop empathetic projects, they learn to see real needs, not only perceived ones, in order to propose a real solution. The problems of companies and communities are business opportunities and potential ventures. So, it is necessary to cultivate empathy, to understand the problems.

G3.3.5. Question 5	
G3.3.5.1	We are creating an online platform to promote learning in sustainable development in design and architecture education. What would you like to find there?

External guests' response to Question 5	
EG.7	I propose that the online platform be a tool that brings awareness and promotes a change of mentality in sustainability issues, that encourages empathy, that shows statistical data on the situation and on what may happen if we don't act now. It would be a good idea to publish success stories there.

Note: There were no further responses to this final question because the period of time allowed for this focus group had come to an end.

It is worth noting here that some responses given by the external guests were omitted because they were considered too vague or they were unrelated to the other issues or just unsuitable for inclusion within the discussion of the findings.

Appendix H. List of questions included in the Sostek online test

CATEGORIES	SUBCATEGORIES	TAG	QUESTION
Ecosystem	Ecosphere	Impact on biodiversity	In your analysis prior to product design, which of the following factors did you consider?
Ecosystem	Ecosphere	Current state of fauna	Reflect Which of the following is being exploited by the production process of your design?
Ecosystem	Ecosphere	Ecosystem	How does your project contemplate the regeneration of the ecosystem impacted by the use of materials / manufacturing processes?
Ecosystem	Ecosphere	Bioindicators | Services generation	How many bioindicators do you consider in the design of your products?
Ecosystem	Lithosphere	Production site vocation	Will any of the following be directly or indirectly violated by the production process of your design?
Ecosystem	Atmosphere	CO2 cost of the process	During the development of the project, what factors were considered to assess the carbon footprint?
Ecosystem	Atmosphere	CO2 waste mitigation	How do your project reduces or mitigates CO 2 emissions in the environment?
Ecosystem	Hydrosphere	Water consumption of the process	How do you consider that the cost of water will be in the manufacture of your product?
Ecosystem	Hydrosphere	Recovery of aquifers	Do you consider actions aimed at having a closed cycle in the product life cycle?
Socio-Economic	Health Impacts	Production health risks	In the selection of materials and manufacturing processes, do you take into account the production health risk of the people involved?
Socio-Economic	Health Impacts	Health benefits and risks in context	What level of impact on health can your product have in the direct context?

Socio-Economic	Health Impacts	Chemical composition of the product	How does the selection of materials for your product impact the user?
CATEGORIES	**SUBCATEGORIES**	**TAG**	**QUESTION**
Socio-Economic	Economy	Added value in context	How does your design generate added value to the user?
Socio-Economic	Economy	Fair Trade	Is fair trade a qualifying adjective that you could give your project, from the creation process to its use?
Socio-Economic	Economy	Adaptation to climate change	Will the designed product be the only one of its kind that the user needs to purchase and / or is it intended to be disposable or frequently replaced?
Socio-Economic	Economy	Resilience to natural phenomena	Does your product support the user's resilience to natural phenomena?
Socio-Economic	Economy	Energy self-sufficiency	Do you promote energy self-sufficiency as a designer?
Socio-Economic	Economy	Self-sufficiency of use	Does the product have a second useful life beyond its initial function?
Socio-Economic	Economy	Consumption self-sufficiency	Does your product support the self-sufficiency of user consumption?
Socio-Economic	Safety	Production welfare promotion	Does your product promote production welfare?
Socio-Economic	Safety	Adaptation to the social fabric	Do you consider that your product adapts to the local social fabric?
Socio-Economic	Safety	Social inclusion	Do you consider that your product promotes the participation and inclusion of vulnerable sectors of the population?
Socio-Economic	Safety	Environmental value in the surroundings	As a designer, do you actively promote environmental value in the environment?
Socio-Economic	Safety	Active citizenship	Do you promote as a designer the values linked to an active citizenship?