Development of an Educational Intervention to Enhance Interest on Sustainable Design

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To my Inspiration,
I love you the most
and I hate you the most

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ABSTRACT

INTRODUCTION

The evolution of life spent millions of years to achieve the level of complexity and diversity that can be appreciated today in planet Earth. Because human actions in the last two hundred years have impacted life in fundamental and irreversible ways, such actions and their causes should be analysed critically to act in consequence. However, the participation of designers in the transition to a healthier and fairer world is yet to be fully explored.

Sustainable design is design that takes on account economic, social and ecological systems in which the design object is immersed. It requires a shift from linear thinking to complex thinking, so although sustainable design has been promoted for decades, its integration in design education and professional practice has mixed levels of acceptance. Nonetheless, designers have to find ways to understand and explain their own role in a world that aims for sustainability, and that is not going to wait for anyone who keeps doing “business as usual”.

OBJECTIVES

The present research explored interest on sustainable design through quantitative and qualitative analysis, describing objective (contextual) and subjective factors related to the practice of sustainable design. It also described factors that inhibit or discourage its practice. The object and space of analysis was YouTube videos, as they have become widely popular and are easily available as educative materials.

METHODS

Psychological studies on general environmental behaviors were reviewed. Ecological and feminist theories for design were synthetized to propose the field of *Bio Speculative Design* as a critical lens for the research.

Information about YouTube videos related to sustainable design in the English and Spanish languages was collected. In terms of operational definitions, contextual and emotional factors for design objects were employed for data classification. Regarding analysis procedures, network theory and theory of emotions expressed in the cyberspace (*Cyberemotions*) were instrumentalized through video network graphs, semantic network graphs and emotion graphs. Statistical analyses for non-parametric data and for networked data were employed to find relationships, differences and predictors. Throughout these processes, qualitative analysis of random samples of data complemented the findings.

In concrete, Chapter III described characteristics of sustainable design video networks, characteristics of popular videos related to sustainable design, and tried to determine which contextual factors were related to the popularity of videos.

Chapter IV centers in comments found in the videos, considering text and graphical representations. This chapter explored contextual and subjective factors related to positive and negative emotions. It also explored coincidences and similarities in terms of emotions, motivations and barriers for sustainable design in English and Spanish, uncovering which topics are emotional and which ones are neutral (objective).

Chapter V applied findings of Chapters IV and V to develop an educational intervention, consisting of a video recommendation system paired with human guidance based on environmental psychology, sociology of emotions and implementation intentions. A comparison test between YouTube and the system; and an evaluation of the educational intervention were performed. Three groups of English and Spanish speakers were recruited: one group watched videos related to sustainable design in YouTube, another group used the recommendation system, and the third group used the recommendation system paired with human guidance. Some participants eye gaze was tracked while they were watching videos.

RESULTS

- Based on Chapter III:
    - The English network was organized as big clusters with multiple interconnections between videos uploaded by universities and other stakeholders, while the Spanish network was organized in small clusters with few connections.
    - University related content was less popular than content from other sources in both languages; while English videos were more popular than Spanish videos.
    - Although architecture videos were the most numerous and popular, they were followed by videos from the general area in English, while in Spanish, they were followed by videos from the mixed area. This difference in activities reflects the economic-political power dynamics between English and Spanish speaking countries.
    - Videos related to sustainable design were frequently shared through other social networking sites and websites that function as document repositories.
    - Contextual factors could not explain the popularity of videos through the chosen analysis method.
- Based on Chapter IV:
    - English commenters expressed theory orientation, war aversion, negative views on religion, ecophilia towards animals, ecophobia related to fear, and environmental privilege. In contrast, Spanish commenters showed project orientation, individual female representation, Do It Yourself attitude, concern about lack of monetary, knowledge and professional resources, lack of fit to local contexts, religion as a positive (communal) aspect, ecophilia towards natural elements, and some ecophobia related to disgust.
    - Comments in both languages expressed a problem-solving interdisciplinary mindset, humble role models and women, ecophilia towards plants and acceptance of complexity. Negativity towards ignorance, people, society, and the economic-political system were frequent barriers for the acceptance of sustainable design.
    - Relationships between designers and other stakeholders confirmed the need to connect design practitioners to other sectors of the society. The

positive role of a supportive community, trust and interchange of information was noted.

  - Emotional (people and money) and non-emotional (design and engineering) topics in comments related to videos about sustainable design were uncovered. Overall, nature related topics also elicited positive emotions.

- Based on Chapter V:
  - While videos illustrating complex and/or subjective concepts made sustainable design more understandable for novice viewers, videos showing designers, concrete methods, and products and services, helped expert viewers to acquire new ideas or reaffirm pro-environmental behaviours. By focusing in human role models and showing the beneficial effects of sustainable design in humans, videos can potentially foster the adoption of pro-environmental behaviours in the design process.
  - While YouTube users showed a decline of interest in sustainable design 2 months after watching videos, the recommendation system users kept doing sustainable design projects. Moreover, their definitions of sustainable design were more integrated and complex 2 months after the intervention.
  - While both English and Spanish speakers have similar systemic, psycho-social and formal needs related to sustainable design, they also have different needs. The implementation intentions part of the intervention further supported and personalized the experience, making it more relevant for the participants and correcting some wrong assumptions based on the videos.
  - Asian participants had an overall westernized conceptualization of sustainable design, also showing a decline on the concept of circular time. However, inclusion of living beings in the videos apparently aided their comprehension of the topic.

DISCUSSION

Chapter III uncovered video network structures that reflect English and Spanish speaking societies. In English, the numerous links found between videos uploaded by universities, companies and media channels partly point to a perception of sustainable design as complex by the viewers, aided by the advanced internet infrastructure in English speaking countries. However, the implications of having mostly WEIRD (Westernized, Educated, Industrialized, Rich, Developed) countries videos is lack of creative diversity and representation. Also, the larger availability of English videos in YouTube combined with a perception of Latin American materials as inferior by both English and Spanish speakers may be playing a part on the low interactivity and popularity of Spanish videos.

Although design as stylization (superficial beautification) was present in English, the considerable number of discarded videos that had to do with stylization in Spanish suggests that the word design is strongly connected to beautification in this language. This might also be related to the low technification of design in most Spanish speaking countries, where design tends to be viewed as hand-made and in less professional terms. On the other hand, the great number of videos related to fashion design contained in the Mixed area in Spanish videos was partly due to algorithmic bias benefiting Spain, which had the biggest number of videos related to sustainable design in Spanish. In sum, research results have implications on an era towards web 4.0 (fully ubiquitous), as universities decide how to approach and use technology to diffuse their activities.

Chapter IV deepened the understanding of objective (contextual) and subjective factors related to sustainable design. Several English comments expressed an effort to understand others point of view, and argumentation was (generally) in a respectful manner, avoiding violence. It was found that women had a relevant role, but that they were frequently called "she". The implication of not using women designers' names is that they can't be detected by search engines and therefore, their videos are harder to find than those portraying men. As for some negative emotions uncovered, religion was connected to ignorance and fear was related to environmental disasters. This refers to solastalgia, the pain associated to the radical change or loss of a loved place.

Spanish comments expressed sadness related to lack of information and professionals in Spanish speaking countries, which is in turn influenced by egalitarianism (e.g. mentioning profession is not considered important and hence frequently omitted in the videos) and the limited visibility of YouTube videos in this language (pointing to algorithmic bias). Although both networks comments showed barriers for sustainable design, Spanish videos commenters expressed intentions of doing it often. Contrary to beliefs that religion is not useful for rational inquiry, the case of sustainable design in Spanish speaking countries highlights how subtle religious elements aid a more integral view of the world, where the designer recognizes the value of nature.

Among coincidences found between the two languages, anger, disgust and fear were connected to ineffective design. Role models in the videos tended to show less traditional characteristics attributed to men and long comments stimulated knowledge interchange associated with trust. Negative emotions were also associated to a perception of sustainable design as ugly.

Given that designers tended to be perceived as isolated from other stakeholders, it is imperative to foster empathy, constructive criticism and proactive ways of dealing with pain in the design process. Although incomplete, the knowledge a designer possesses could avert much of the damage industries do, if paired with correct assistance by others.

Chapter V proposed an educational intervention with a video recommendation system and human guidance to foster interest in sustainable design. Videos aid the perception of sustainable design as real in two ways: images can represent abstract concepts effectively for viewers who have difficulties grasping complex abstractions; while the testimony, methodologies and work of real designers can ground the concepts into concrete products and services.

The proposed recommendation system acts as an automatized gatekeeper based in a human gatekeeper on videos chosen by another automatized gatekeeper (YouTube's algorithm) and many other human gatekeepers (those who interacted with the videos in YouTube). As for the overall educational intervention, it reveals the possibilities of re-thinking technology in educational contexts through a sustainable design perspective, while also confronting the power dynamics between WEIRD and non-WEIRD communities.

With the limited nature related courses in some art, design and engineering schools, an urgent need to connect designers to other living beings and the environment also emerged. Practicing a more sustainable design would require a conciliation between individual, socio-cultural and environmental contradictions. In such regards, the acronym KAPAC is being proposed, understood as Knowledge not necessarily acquired through official institutions; Artisanal in terms of acts augmented/extended through traditional and modern technology; Plural because it embodies the many voices it serves; Abundant because it preserves diversity to foster prosperity for all life; and Communal because communities are at the centre of its governance. Although imperfect, the educational intervention aims towards the aforementioned characteristics.

CONCLUSIONS

The present research analyzed interest related to sustainable design in Video Social Networks to propose an educational intervention to enhance interest in the topic. Main findings include:

1. The materialization of a more sustainable technology for watching videos should involve human participation.
2. Several formal, politico-economic, socio-cultural, and psychological features favour the interest on theories related to sustainable design, while practice and the contexts where it is more frequently practiced are made less visible.
3. Positive views of sustainable design are related to an acceptance of complexity, interdisciplinarity, problem-solving mindset, community values, and personality characteristics traditionally associated to women.
4. Main barriers for sustainable design include people, society, economic-political system, lack of effectiveness and lack of adequate information to practice it.
5. Moderately positive emotions and a high interest in Sustainable Design might enhance its practice.
6. However, congruency between the design field and information/education received might be more relevant than interest and emotions related to the practice of Sustainable Design.

持続可能なデザインへの興味を高めるための教育的支援開発

要約

導入

生命の進化は、今日地球で認められる複雑さと多様性のレベルを達成するために数百万年を費やした。 過去2000年間の人間の行動は根本的かつ不可逆的な方法で生活に影響を与えてきたので、そのような行動とそれらの原因は、その結果に基づいて行動するために、批判的に分析されるべきである。 しかし、より健康で公平な世界への移行におけるデザイナーの参加は未だ十分に検討されていない。

持続可能なデザインとは、デザイン作品が含まれている経済的、社会的、生態学的なシステムを考慮に入れたデザインである。 それは線形思考から複雑な思考への移行を必要するため、持続可能なデザインは何十年もの間促進されたのに、デザイン教育とプロの実践における、統合の受け入れ度合は様々である。それにもかかわらず、デザイナーは持続可能性を目的とし、「いつものようなビジネス」をし続ける誰かを待つつもりはない世界における彼ら自身の役割を理解し説明する方法を見つけなければならない。

目的

本研究は、持続可能なデザインの実践に関連する客観的（文脈的）、主観的要因を記述し、量的、質的分析を通して持続可能なデザインへの関心を探った。 また、その練習を妨げるあるいは、思いとどまらせる要因を記述した。広く普及しており、教育資料として簡単に入手できることから、分析の目的と空間は YouTube のビデオとした。

方法

一般的な環境行動に関する心理学的研究をレビューした。 デザインのための生態学的でフェミニスト理論は、研究のための重要なレンズとしてバイオスペキュレーティブデザインの分野を提案するために合成された。

英語とスペイン語の持続可能なデザインに関連するYouTubeビデオの情報が集められた。 操作上の定義に関して、デザイン作品のための文脈上と感情上の要因がデータ分類のために採用された。 分析手順に関して、ネットワーク理論とサイバースペースで表現された感情の理論（サイバー感情）が、ビデオネットワークグラフ、セマンティックネットワークグラフと感情グラフを通して器械化された。 ノンパラメトリックデータとネットワークデータについての統計分析を用いて、関係、差異と予測因子を見いだした。 これらの過程で、データの無作為標本の定性分析がこの発見を補完した。

具体的には、第3章では、持続可能なデザインのビデオネットワークの特徴、持続可能なデザインに関連する人気のあるビデオの特徴について説明し、どの文脈要因がビデオの人気に関連するのかを判断しようとした。

第4章では、テキストとグラフィック表現を考慮して、ビデオで見つかったコメントを中心に説明した。 この章では、ポジティブな感情とネガティブな感情に関連する文脈的で主観的要因について探った。 また、英語とスペイン語の持続可能なデザインに対する感情、動機、障壁の点での偶然の一致と類似点を探り、どのトピックが感情的でどのトピックが中立的（客観的）であるかを明らかにした。

第5章では、環境心理学、感情の社会学と実施意図に基づく人間の指導と対になったビデオ推薦システムからなる教育的介入を開発するために、第4章および第5章の調査結果を適用した。 YouTubeとシステム間の比較テスト； 教育的介入の評価が行われた。 英語とスペイン語の話者の3つのグループが募集された：1つのグループはYouTubeで持続可能なデザインに関連するビデオを見て、他のグループは推薦システムを使い、3番目のグループは人間の指導と組み合わせた推薦システムを使った。 何人かの参加者は、彼らがビデオを見ている間に視線が追跡された。

結果

- 第3章に基づく：
  - 英語ネットワークは大学や他の利害関係者によってアップロードされたビデオ間に複数の相互接続がある大きなクラスターとして編成されていたが、スペインのネットワークは少ない接続で小さなクラスターに編成されていた。
  - 大学関連のコンテンツは、両方の言語の他のソースからのコンテンツよりも人気がなかった。 一方、英語のビデオはスペインのビデオよりも人気があった。
  - 建築用ビデオが最も多く、人気があったが、英語では、一般的な分野からのビデオが続き、スペイン語では、混合地域からのビデオが続いた。 この活動の違いは、英語圏とスペイン語圏の国々の間の経済政治的権力の力学を反映している。
  - 持続可能なデザインに関連するビデオは、他のソーシャルネットワーキングサイトやドキュメントリポジトリとして機能するウエブサイトで頻繁に共有されていた。
  - 文脈上の要因は、選択された分析方法ではビデオの人気を説明できなかった。
- 第4章に基づく：
  - 英国のコメンター達は、理論志向、戦争嫌悪、宗教に対する否定的見解、動物に対するエコフィリア、恐怖に関連したエコフォビア、そして環境特権を表明した。 対照的に、スペイン語のコメンターは、プロジェクトの方向性、個々の女性の表情、DIY の態度、金銭的知識、知識と専門的資源の欠如に対する懸念、地域の文脈への適合の欠如、前向きな（共同）側面としての宗教、自然要素へのエコフィリア、 そして嫌悪感に関連するいくつかのエコフォビア。
  - 両方の言語でのコメントは、問題解決の学際的な考え方、謙虚な役割モデルと女性、植物へのエコフィリアと複雑さの受け入れを表明した。 無知、人、社会、そして経済 - 政治システムへの否定的な反応は、持続可能なデザインを受け入れる上での障害となりがちであった。
  - デザイナーと他の利害関係者との間の関係は、設計実務家を社会の他の部門に結び付ける必要性を確認した。 協力的なコミュニティ、情報の信頼と交換の積極的な役割が注目された。

   - 持続可能なデザインについてのビデオに関連するコメントの中で、感情的（人とお金）と非感情的（デザインと工学）のトピックが発見された。 全体的に見て、自然に関連した話題も肯定的な感情を引き出した。
- 第5章に基づく：
   - 複雑で主観的な概念を説明するビデオは、初心者の視聴者にとって持続可能なデザインをもっとわかりやすくし、デザイナー、具体的な方法、製品やサービスを紹介するビデオは、新しいアイディアの獲得やプロの環境行動の再確認を助けた。人間の役割モデルに焦点を当て、人間の持続可能なデザインの有益な効果を示すことによって、ビデオはデザインプロセスにおけるプロ環境行動の採用を促進する可能性がある。
   - YouTube ユーザーは、ビデオを見て2か月後に持続可能なデザインへの関心の低下を示したが、リコメンデーションシステムユーザーはサ持続可能なデザインプロジェクトを続けた。さらに、持続可能なデザインの定義は、介入から2か月後に、より統合され複雑になった。
- 英語とスペイン語を話す人は、持続可能なデザインに関連して、同様の体系的、心理社会的、形式的なニーズを持っているが、異なるニーズも持っている。介入の実施意図の一部はさらに経験を支持し個人化し、それを参加者にとってもっと関連性のあるものにして、ビデオに基づいていくつかの誤った仮定を修正した。
- アジアの参加者は持続可能なデザインの全体的に西洋化された概念化を持っていて、また循環時間の概念の減少を示した。しかし、ビデオに生き物を含めることは明らかに話題の理解を助けた。

結論

第3章では、英語とスペイン語を話す社会を反映したビデオネットワーク構造を明らかにした。 英語では、大学、企業とメディアチャンネルによってアップロードされたビデオの間に見られる多数のリンクは、英語圏の先進的なインターネットインフラによって支援されて、視聴者にとって複雑な持続可能なデザインの認識を部分的に示す。 しかし、主に WEIRD（欧米化された、教育された、工業化された、裕福な、開発された）の国のビデオを持つことの意味は、創造的な多様性と表現の欠如だ。 また、英語とスペイン語の話者による

ラテンアメリカの材料が、劣っているという認識と結合された YouTube での英語のビデオのより大きな入手可能性は、スペイン語のビデオの低い双方向性と人気に役割を果たしているかもしれない。

様式化（表面美化）としてのデザインは英語で存在していたが、スペイン語の様式化と関係していたかなりの数の廃棄されたビデオは、デザインという言葉がこの言語の美化と強く関連していることを示唆する。 これはまた、デザインが手作りと見なされ、専門的な意味が少ない、スペイン語圏のほとんどの国々におけるデザインの技術の低さにも関連している可能性がある。 その一方で、スペインのビデオのミックスエリアに含まれるファッションデザインに関連するビデオの数が多かったのは、スペインの持続可能なデザインに関連するビデオの数が最も多かったスペインの恩恵を受けていたためだ。 まとめると、研究の成果は、大学が自らの活動を普及させるためのテクノロジーへのアプローチおよび使用方法を決定するため、Web 4.0（完全にユビキタス）への時代に影響する。

第4章では、持続可能なデザインに関連する客観的（文脈的）と主観的要因の理解を深めた。 いくつかの英語のコメントは他者の見解を理解するための努力を表明して、議論は（一般的に）暴力を避けるために礼儀正しい態度でなれた。女性には適切な役割があることがわかったが、「彼女」と呼ばれていた。 女性デザイナーの名前を使用しないことの意味は、検索エンジンによって検出されることができないので、女性のビデオは男性を描写するものより見つけるのが難しい。 明らかにされたいくつかの否定的な感情に関しては、宗教は無知とつながり、恐怖は環境災害と関連していた。 これは、眼瞼炎、根本的な変化または愛された場所の喪失に伴う痛みを意味する。

スペインのコメントはスペイン語圏の国々で情報や専門家が不足していることに悲しみを表明していた。そして、それは平等主義（職業への言及は重要ではないと考えられており、ゆえにビデオの中で頻繁に省略されていた）や、この言語での YouTube 動画の限定的な表示（アルゴリズムの偏りを指す）に影響を受けていた。どちらのネットワークのコメントも持続可能なデザインに対する障壁を示していたが、スペインのビデオコメンターはそれを頻繁に行う意向を表明した。 宗教は合理的な探究には役に立たないとの信念に反して、スペイン語圏の国々における持続可能なデザインのケースは、デザイナーが自然の価値を認める微妙な宗教的要素がいかに世界のより重要な見方を助けるかを強調している。

2つの言語の間で見つかった偶然の一致の中で、怒り、嫌悪感と恐怖は無効なデザインに関連していた。 ビデオのロールモデルは男性に起因する伝統的な特性が少ないことを示す傾向があり、長いコメントは信頼に関連する知識の交換

を促進した。 否定的な感情もまた、持続可能なデザインに対する醜い認識に関連していた。

デザイナーが他の利害関係者から孤立していると見なされる傾向があることを考えると、デザインプロセスにおける共感、建設的な批判と積極的な痛みへの対処方法を促進することが不可欠だ。 不完全ではあるものの、デザイナーが持っている知識は、他の人々による正しい支援と組み合わせると、業界が受ける損害の多くを回避することができる。

第5章では、持続可能なデザインへの関心を高めるために、ビデオ推薦システムと人間の指導による教育的介入を提案した。 ビデオは、2つの方法で持続可能なデザインの現実を認識するのに役立つ。複雑な抽象化を理解するのが困難な視聴者にとって、画像は抽象的な概念を効果的に表すことができる。 実際のデザイナーの証言、方法論そして仕事は具体的な製品とサービスに概念を根付かせることもできる。

提案されたリコメンデーションシステムは、他の自動ゲートキーパー（YouTube のアルゴリズム）と他の多くの人間ゲートキーパー（YouTube のビデオを操作した人）によって選択され人間ゲートキーパーにおけるに基づく自動ゲートキーパーとして機能する。 全体的な教育的介入に関しては、それは持続可能なデザインの視点を通して教育の文脈でテクノロジーを再考することの可能性を明らかにしながら、同時に WEIRD と非 WEIRD コミュニティ間の力の力学に直面している。

アート、デザイン、エンジニアリングの学校では自然に関連するコースが限られているため、デザイナーを他の生き物や環境と結びつけることが急務となっている。 より持続可能なデザインを実践することは、個々の、社会文化的な、そして環境的な矛盾の間の調整を必要とするであろう。 そのような意味で、頭字語をとった KAPAC が提案されている。知識は必ずしも公的機関を通じて取得されるわけではない。 行為の点での職人は伝統的な、そして現代の技術を通して増大/拡張した。それが役立つ多くの声を具体化しているので複数である。一生の繁栄を促進するために多様性を維持しているので豊富である。 なぜなら、コミュニティはその統治の中心にあるからだ。 不完全ではあるが、教育的介入は前述の特徴を目指している。

結論

本研究は、トピックへの関心を高めるための教育的介入を提案するために、ビデオソーシャルネットワークにおける持続可能なデザインに関する関心を分析した。 主な研究結果は次のとおりである：

1.ビデオを見るためのより持続可能な技術の実現には、人間の参加が必要だ。
2.いくつかの形式的、政治経済的、社会文化的、そして心理的な特徴は、持続可能なデザインに関連する理論への関心を支持する一方、実践と、それがより頻繁に実践される文脈は見えにくくされる。
3.持続可能なデザインに対する前向きな見方は、複雑さ、学際性、問題解決の考え方、コミュニティの価値観、そして伝統的に女性に関連する人格特性の受容に関連している。
4.持続可能なデザインの主な障害には、人、社会、経済 - 政治システム、効果の欠如、そしてそれを実践するための十分な情報の欠如が含まれる。
5.中程度に前向きな感情と持続可能なデザインへの高い関心はその実践を強化するかもしれない。
6.しかし、デザイン分野と受け取った情報/教育との一致は、持続可能なデザインの実践に関連する興味や感情よりも関連性があるかもしれない。

Desarrollo de una Intervención Educativa para Fomentar el Interés en el Diseño Sustentable

RESUMEN

INTRODUCCIÓN

La evolución de la vida requirió millones de años para alcanzar el nivel de complejidad y diversidad que apreciamos hoy en el planeta Tierra. Debido a que las acciones humanas en los últimos doscientos años han impactado la vida de manera fundamental e irreversible, tales acciones y sus causas deben ser analizadas críticamente para actuar en consecuencia. Sin embargo, la participación de los diseñadores en la transición hacia un mundo más sano y más justo aún no ha sido suficientemente explorada.

El diseño sustentable es aquel que toma en cuenta los sistemas económicos, sociales y ecológicos en los que se encuentra inmerso el objeto de diseño. Esto requiere un cambio del pensamiento lineal al pensamiento complejo, por lo que aunque el diseño sostenible ha sido promovido durante décadas, su integración en la educación y práctica profesional del diseño tiene niveles de aceptación mixtos. No obstante, los diseñadores deben de encontrar maneras de comprender y explicar su propio rol en un mundo que apunta a la sustentabilidad, y que no va a esperar a quien continúe diseñando "como siempre".

OBJETIVOS

La presente investigación exploró el interés en el diseño sustentable a través de análisis cuantitativos y cualitativos, describiendo factores objetivos (contextuales) y subjetivos relacionados con la práctica del diseño sustentable. También describió factores que inhiben o desalientan su práctica. El objeto y espacio de análisis fueron videos de YouTube, ya que se han hecho muy populares y

están fácilmente disponibles como material educativo.

MÉTODOS

Se revisaron estudios de psicología sobre comportamientos ambientales generales. Teorías ecológicas y feministas del diseño fueron sintetizadas para proponer el campo del *Diseño Bioespeculativo* como marco crítico para la investigación.

Se recopiló información sobre videos de YouTube relacionados con el diseño sostenible en los idiomas inglés y español. En términos de definiciones operativas, factores contextuales y emocionales para objetos de diseño fueron revisados y empleados para la clasificación de datos. Con respecto a procedimientos de análisis, teoría de redes y teoría de emociones expresadas en el ciberespacio (*ciberemociones*) se instrumentaron a través de gráficos de redes de video, gráficos de redes semánticas y gráficos de emociones. Análisis estadísticos para datos no paramétricos y para datos en red se emplearon para encontrar relaciones, diferencias y predictores. A lo largo de estos procesos, el análisis cualitativo de muestras aleatorias de datos complementó los hallazgos.

En concreto, el Capítulo III describió características de las redes de videos de diseño sustentable, características de videos populares relacionados con el diseño sustentable, e intentó determinar qué factores contextuales estaban relacionados con la popularidad de los videos.

El capítulo IV se centra en comentarios encontrados en los videos, considerando texto y representaciones gráficas. Este capítulo exploró factores contextuales y subjetivos relacionados con emociones positivas y negativas. También exploró coincidencias y similitudes en términos de emociones, motivaciones y barreras para el diseño sustentable en inglés y español, describiendo cuáles temas son emocionales y cuáles son neutrales (objetivos).

El Capítulo V aplicó los hallazgos de los Capítulos IV y V para desarrollar una intervención educativa, que consiste en un sistema de recomendación de videos combinado con orientación humana basada en psicología ambiental, sociología de las emociones e intenciones de implementación. Se realizaron una prueba comparativa entre YouTube y el sistema; y una evaluación de la intervención educativa. Se reclutaron tres grupos de anglo e hispano hablantes: un grupo vio videos relacionados con el diseño sustentable en YouTube, otro grupo usó el sistema de recomendación y el tercer grupo usó el sistema de recomendación combinado con orientación humana. A algunos participantes se les hizo un seguimiento visual mientras miraban videos.

RESULTADOS

- Basados en el Capítulo III:
  - La red en inglés está organizada en grandes grupos con múltiples interconexiones entre videos subidos por las universidades y otras partes interesadas, mientras que la red en español está organizada en pequeños grupos con pocas conexiones.
  - El contenido relacionado con universidades fue menos popular que el contenido de otras fuentes en ambos idiomas; mientras que los videos en inglés fueron más populares que los videos en español.
  - Aunque los videos de arquitectura fueron los más numerosos y populares, fueron seguidos por videos del área general en inglés, mientras que en el caso del español, fueron seguidos por videos del área mixta. Esta diferencia en actividades refleja la dinámica de poder económico-político entre países de habla inglesa y española.
  - Los videos relacionados con diseño sustentable se compartieron frecuentemente en otras redes sociales y sitios web que funcionan como repositorios de documentos.
  - Los factores contextuales no pudieron explicar la popularidad de los videos a través del método de análisis empleado.
- Basados en el Capítulo IV:
  - Comentaristas en inglés expresaron orientación teórica, aversión a la guerra, opiniones negativas sobre la religión, ecofilia hacia animales, ecofobia relacionada con miedo y privilegio ambiental. En contraste, comentaristas en español mostraron orientación a proyectos, representación femenina individual, actitud de "Hazlo Tú Mismo", preocupación por la falta de recursos monetarios, de conocimiento y profesionales, falta de ajuste a los contextos locales, la religión como aspecto positivo (comunitario), ecofilia hacia elementos naturales, y algo de ecofobia relacionada al disgusto.
  - Los comentarios en ambos idiomas expresaron una mentalidad

interdisciplinaria para resolver problemas, modelos de conducta humildes y usualmente relacionados a mujeres, ecofilia hacia plantas y aceptación por la complejidad. La negatividad hacia la ignorancia, las personas, la sociedad y el sistema económico-político eran barreras frecuentes para la aceptación del diseño sustentable.

  - Las relaciones entre los diseñadores y otras partes interesadas confirmaron la necesidad de conectar a los profesionales del diseño con otros sectores de la sociedad. Se observó el papel positivo de una comunidad de apoyo, la confianza y el intercambio de información.
  - Se descubrieron cuáles temas son emocionales (personas y dinero) y no emocionales (diseño e ingeniería) en los comentarios relacionados con videos sobre diseño sustentable. En general, los temas relacionados con la naturaleza también provocaron emociones positivas.
- Basados en el Capítulo V:
  - Mientras que los videos que ilustran conceptos complejos y/o subjetivos hacen que el diseño sustentable sea más comprensible para usuarios novatos, los videos que muestran diseñadores, métodos y productos y servicios concretos ayudaron a los expertos a adquirir nuevas ideas o reafirmar comportamientos en pro del medio ambiente. Al enfocarse en diseñadores y mostrar efectos beneficiosos del diseño sustentable en seres humanos, los videos pueden potencialmente fomentar la adopción de comportamientos proambientales en el proceso de diseño.
  - Si bien los usuarios de YouTube mostraron una disminución en el interés por el diseño sostenible 2 meses después de ver videos, los usuarios del sistema de recomendación siguieron realizando proyectos de diseño sostenible. Además, sus definiciones de diseño sostenible estuvieron más integradas y complejas 2 meses después de la intervención.
  - Si bien los anglo e hispano hablantes tienen necesidades sistémicas, psicosociales y formales similares relacionadas con el diseño sustentable, también tienen necesidades diferentes. Las intenciones de implementación respaldaron y personalizaron la intervención educativa, haciéndola más relevante para los participantes y corrigiendo algunos supuestos erróneos basados en los videos.

- Los participantes asiáticos en general tuvieron una conceptualización occidentalizada del diseño sustentable, también mostrando una disminución en el concepto de tiempo circular. Sin embargo, la inclusión de seres vivos en los videos aparentemente ayudó a la comprensión del tema.

DISCUSIÓN

El Capítulo III descubrió estructuras de redes de video que son un reflejo de las sociedades de habla inglesa y española. En el caso del inglés, los numerosos enlaces encontrados entre los videos subidos por universidades, empresas y canales de medios podrían apuntar en parte a una percepción del diseño sustentable como algo complejo, ayudado por la infraestructura avanzada de Internet en los países de habla inglesa. Sin embargo, las implicaciones de tener principalmente videos de países WEIRD (Occidentalizado, Educado, Industrializado, Rico, Desarrollado) son la falta de diversidad y representación creativa. Además, la mayor disponibilidad de videos en inglés en YouTube combinada con una percepción de los materiales latinoamericanos como inferiores tanto por parte de angloparlantes como de hispanohablantes puede influenciar la baja interactividad y la popularidad de los videos en español.

Si bien el diseño como estilización (cosmética superficial) estaba presente en inglés, el número considerable de videos descartados que tenían que ver con la estilización en español sugiere que la palabra diseño está estrechamente relacionada con la cosmética superficial en este idioma. Esto también podría estar relacionado con la modesta tecnología del diseño en la mayoría de los países de habla hispana, donde el diseño tiende a verse como hecho a mano y en términos menos profesionales. Por otro lado, la cantidad de videos relacionados con el diseño de moda contenido en el área Mixta en los videos en español se debió en parte al sesgo algorítmico que beneficia a España, que contaba con el mayor número de videos relacionados con diseño sustentable en español. En resumen, los resultados de la investigación tienen implicaciones en una era hacia la web 4.0 (totalmente ubicua), ya que las universidades deben decidir cómo enfocar y usar la tecnología para difundir sus actividades.

El Capítulo IV profundizó la comprensión de los factores objetivos (contextuales) y subjetivos relacionados con el diseño sustentable. Varios comentarios en inglés expresaron un esfuerzo por comprender el punto de vista de otros, y la argumentación fue (en general) de manera respetuosa, reflejando evitación de la violencia. Se encontró que las mujeres tenían un papel relevante, pero que a menudo se las llamaba "ella". La implicación de no utilizar los nombres de las diseñadoras es que no pueden ser detectadas por los motores de búsqueda y, por lo tanto, sus videos son más difíciles de encontrar que los que retratan a los hombres. En cuanto a algunas emociones negativas, la religión estaba relacionada con la ignorancia y el miedo estaba relacionado con los desastres ambientales, lo que se refiere a la solastalgia, el dolor asociado al cambio radical o la pérdida de un lugar querido.

Los comentarios en español expresaron tristeza relacionada con la falta de información y profesionales suficientes en los países de habla hispana, que a su vez está influenciada por el igualitarismo (por ejemplo, mencionar la profesión se considera irrelevante y, por lo tanto, se omite en los videos) y la visibilidad limitada de los videos de YouTube en este lenguaje (apuntando a sesgo algorítmico). Aunque los comentarios de ambas redes mostraron barreras para el diseño sustentable, los comentaristas de videos en español expresaron sus intenciones de hacerlo a menudo. Contrariamente a las creencias de que la religión no es útil para la investigación racional, el caso del diseño sustentable en los países de habla española destaca cómo elementos religiosos sutiles ayudan a una visión más integral del mundo, donde el diseñador reconoce el valor de la naturaleza.

Entre las coincidencias encontradas entre los dos idiomas, el enfado, el disgusto y el miedo estaban conectados a un diseño ineficaz. Personas ejemplares en los videos tienden a mostrar características menos tradicionales atribuidas a los hombres. Además, los comentarios largos estimularon el intercambio de conocimiento asociado con la confianza. Las emociones negativas también se asociaron a una percepción del diseño sustentable como feo.

Dado que los diseñadores tienden a ser percibidos como aislados de otros actores interesados, es imperativo fomentar la empatía, la crítica constructiva y formas proactivas de manejar el dolor en el proceso de diseño. Aunque incompleto, el conocimiento que posee un diseñador podría evitar gran parte del daño que causan las industrias, si es combinado con la asistencia correcta otros.

El Capítulo V propuso una intervención educativa consistente en un sistema de recomendación de videos y orientación humana para fomentar el interés en el diseño sustentable. Los videos ayudan a la percepción del diseño sustentable como real de dos maneras: las imágenes pueden representar conceptos abstractos de manera efectiva para los espectadores que tienen dificultades para comprender abstracciones complejas; mientras que el testimonio, las metodologías y el trabajo de diseñadores pueden aterrizar los conceptos en productos y servicios concretos.

El sistema de recomendación propuesto actúa como un controlador de acceso automatizado basado en un controlador de acceso humano en videos elegidos por otro controlador de acceso automatizado (el algoritmo de YouTube) y muchos otros controladores de acceso humanos (aquellos que interactuaron con los videos en YouTube). En cuanto a la intervención educativa general, revela las posibilidades de repensar la tecnología en contextos educativos a través de una perspectiva de diseño sustentable, a la vez que confronta las dinámicas de poder entre las comunidades WEIRD y no WEIRD.

Tomando en cuenta los limitados cursos relacionados con la naturaleza en algunas escuelas de arte, diseño e ingeniería, también surge la necesidad urgente de conectar a los diseñadores con otros seres vivos y el medio ambiente. Practicar un diseño más sustentable requeriría una conciliación entre sus propias contradicciones individuales, socioculturales y ambientales. En tal sentido se propone el acrónimo KAPAC, entendido como (K)Conocimiento no necesariamente adquirido a través de instituciones oficiales; Artesanal en términos de actos aumentados/extendidos a través de tecnología tradicional y moderna; Plural porque incorpora las muchas voces que sirve; Abundante porque preserva la diversidad con el fin de fomentar la prosperidad para todas las formas de vida; y Comunal porque las comunidades están en el centro de su gobernanza. Aunque imperfecta, la intervención educativa apunta hacia las características antes mencionadas.

CONCLUSIONES

La presente investigación analizó el interés en el diseño sustentable en redes sociales de video para proponer una intervención educativa con el fin de fomentar el interés en el tema. Los principales hallazgos incluyen:

1. La materialización de una tecnología más sustentable para ver videos debe involucrar a la participación humana.
2. Varias características formales, político-económicas, socioculturales y psicológicas favorecen el interés en las teorías relacionadas con el diseño

sustentable, mientras que la práctica y los contextos donde es practicado con más frecuencia tienden a ser menos visibles.

3. Las opiniones positivas del diseño sustentable están relacionadas con aceptación de la complejidad, interdisciplinariedad, mentalidad de solución de problemas, valores relacionados a la comunidad y características personales tradicionalmente asociadas a las mujeres.
4. Las principales barreras para el diseño sustentable incluyen personas, sociedad, sistema económico-político, falta de efectividad y falta de información adecuada para practicarlo.
5. Emociones moderadamente positivas y un gran interés en el diseño sustentable aparentemente fomentan su práctica.
6. No obstante, la congruencia entre el campo de diseño y la información/educación recibida podría ser más relevante que el interés y las emociones relacionadas con la práctica del diseño sustentable.

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CHAPTER I: INTRODUCTION

"When you understand the fabric, you use it better"

-Vu Thao (2016)

1. SUSTAINABLE DESIGN

1.1 What Is Sustainability And Why Should It Matter To Designers

We may never have the whole picture of the beginning of the universe, but what is sure is that the evolution of life took millions of years to achieve the level of complexity and diversity we can appreciate today in planet Earth. That is why human actions in the last two hundred years should be analysed critically, as they have changed life in fundamental and irreversible ways. Despite international efforts to estimate the impact of such changes, there is still much research to be done. What is clear is that the sustainability of life on Earth has been compromised.

The Brundtland Commission developed the concept of sustainability in the document *Our Common Future* (1987). Sustainability is the capacity to endure, considered as the long-term maintenance of responsibility which involve people, economy, society, nature, life support and community categories (United Nations

General Assembly, 2005; United Nations Department of Economic and Social Affairs [UNDESA], 2015). This definition has been applied to an action plan through the Sustainable Development Goals, which were established in collaboration with policy makers, scientists and the public (UNDESA, 2015). The seventeen goals can be summarized as follows:

- Ecological dimension:
    - Ensure availability and sustainable management of fresh water, oceans, terrestrial ecosystems, energy and human settlements.
    - Mitigate climate change, land degradation and biodiversity loss.
- Economical dimension:
    - Ensure economic growth, innovation, sustainable consumption and production patterns.
- Social dimension:
    - End poverty and hunger.
    - Ensure health, education, gender equality, inclusivity, peace and justice.
    - Increase global cooperation for sustainable development.

More recently, the Paris Agreement was negotiated to strengthen global mechanisms targeting climate change, emphasizing compensation, mitigation and support for developing countries. Nations also compromised to report their carbon emissions, although penalization mechanisms were absent in the agreement. In sum, interest on sustainable development has increased in recent years, involving a wide diversity of actors. The participation of designers in the transition to a healthier and fairer world is yet to be fully defined due to several reasons which will be discussed in section 1.3 of the present study. The definition and brief history of sustainability in design will be discussed next.

1.2 Definition And History Of Sustainable Design

Sustainable design is design that seeks to incorporate long term responsibility for the ecological, economic and social systems that support life. This definition can be applied through several levels of sustainable innovation: incremental, re-design, functional and systematic (Charter & Clark, 2007).

It is well known that design answered the formal, functional and symbolic requirements of the Industrial Revolution. Therefore, it's also natural that design reacted to the global environmental concerns in the 60's-70's decades, when the U.N.'s Conference on the Human Environment was held. Meadows et al. (1972) released *The Limits to Growth*, which highlighted the absurdity of conventional economic models. Subsidies for nuclear and fossil-based energy decreased to give priority to decentralized, renewable energy; while in terms of development, support for self-reliance instead of aid was acknowledged (Norberg-Hodge, 2017).

It was in this context that design books such as *Operating Manual for Spaceship Earth* (Fuller, 1969) and *Design for the Real World: Human Ecology and Social Change* (Papanek, 1971) were published, while design technologists such as Ehn incorporated social issues and locality to problem solving (Ehn, P. et al., 2018). Unfortunately, by the late 1980s, there was an increasing emphasis on green consumerism (Norberg-Hodge, 2017). This was partly due to a focus on tangible products (Ceschin & Gaziulusoy, 2018), leaving socio-technical systems focuses to be developed in later decades.

The 2000s decade reconceptualized designed products and services as a part of the lifestyle (Esslinger, 2013). With the publication of Mc Donough and Braungart's *Cradle to Cradle: Remaking the way we make things* (2002), sustainable design had its first massive diffusion. Most professional sustainable design studios were located in the U.S., UK and Europe (Sherin, 2008) by the 2000's, while consumers of these type of products and services were mostly in Japan and the developing world (Charter & Clark, 2007, pg. 16).

1.3 Issues With The Adoption Of Sustainable Design

Although sustainable design has been promoted for over a decade, its integration in design education and professional practice has mixed levels of acceptance. Firstly, there is concern about a lack of standards and ethical guidelines, which extends to the name and concept of sustainable design itself. Denominations like *eco*, *green* and *social* tend to be interchangeable in design practice. Some solutions include operationalizing the concept (using frameworks such as Roth's [1992] or guidelines such as Charter & Clark's [2007]), extend existing guidelines related to architecture and industrial design, or prepare designers to cope with conceptual fluidity and complexity.

There exists a lack of trust in other institutions, skepticism, and resistance to change among professionals, scholars, and other related stakeholders. Design has been deeply interlinked with consumerism, economic profit and technological advance for many years. Thus, the transition from prioritizing economic values to the incorporation of social and environmental values is not fully mainstream yet. However, the consequences of using the Sustainability concept in illegitimate ways (what is called *Greenwashing*) can be serious, long lasting and hugely detrimental (Ottman, 2011). For example, the product/service can be rejected by the users, affect the brand reputation, end up in the landfill, suppose a cultural offense or provoke a loss of jobs (Hanington, 2017). That's why there should be a clear connection with the benefits of sustainable design, which include business growth (e.g. Albizri & Zahedi, 2012), employability, creativity challenges, empowerment, psychological restoration (Vázquez, 2011) and affective (Kansei) appeal (Rasamoelina et al., 2013).

It is difficult to implement, sustain and update projects. This has been especially evident in knowledge sharing platforms related to sustainable design (e.g. BaSiC initiative, DEEDS), which have only been active for a few years. The consequence is a less comprehensive assessment of the impact of such projects. Therefore, rising awareness on the importance of continuous evaluation and more information on hybrid implementation methods and funding options is required.

Common approaches to assess sustainability are quantitative, but rarely qualitative (Hendrickson & Wittman, 2010). Carter (2013) proposes to include sustainable cultures and users behavior/value change within the assessment of sustainable design; while Hanington (2017) discusses the use of design ethnography, consisting of detailed descriptions of social life and culture through observations, unstructured interviews, analysis of documents, etc.

There is a communication and mentorship gap. Although there have been numerous books, papers, conferences, webpages and university programs, there still is a lack of rapid/effective communication and role models/mentorship on sustainable design.

Sustainable design (with some notable exceptions such as *Designmatters*) is taught as a separate subject or extra course. The tendency for Sustainability studies is heading towards understanding planetary boundaries and how to either avoid crossing them or go back to the limit thresholds (Rockström et al., 2009). This is a highly interdisciplinary and collaborative challenge which requires scholars and professionals from all fields and backgrounds. The implication for designers is that we must acquire knowledge in economic, ecologic and social sciences to communicate effectively with other professionals. If it is not possible to incorporate Sustainability in all the levels of an educational institution (yet), educators and students should at least be aware of what is expected from current and future designers.

A change of focus from *clients* and *design objects*, to *systems*, *processes* and *relationships* is required, but such concepts are not easy to visualize. This change of focus echoes the latest proposals on pedagogy and research, which re-link humans to the complex relationships we have with other life forms and promotes the learning of the "meaning of things for daily life" (Gutiérrez & Prado, 1999; Prado, 2006; Gadotti, 2010; Alawad & Mahgoub, 2014). There is also a need to understand the impact of globalization among designers (Bourn, 2017), as the design practice itself has become less rooted in local geographies. Again, Carter (2013) suggests finding ways to explain and deal with the complexity of the designer role in the world, including the designer as educator and "understanding the lasting effects of design decisions using insight from social sciences".

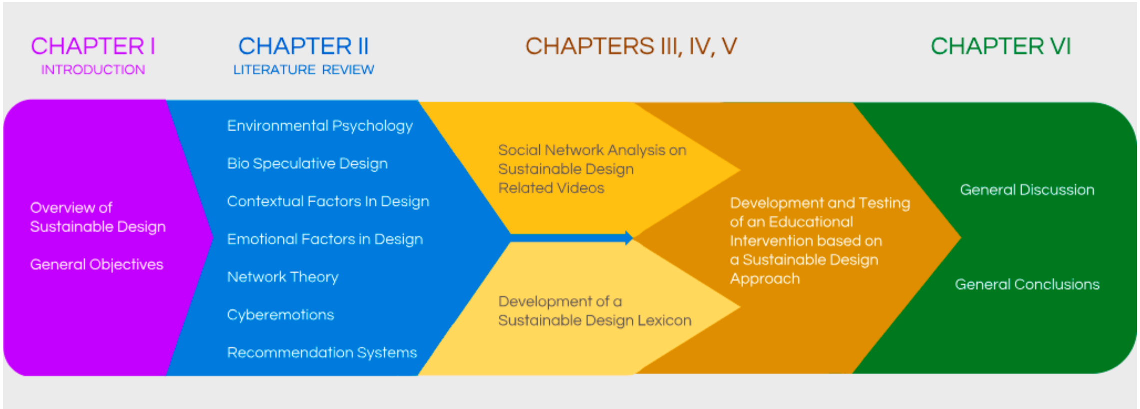
2. GENERAL OBJECTIVES

The present research will mostly engage with qualitative assessment of sustain-nable design, the resistance to change by designers and other creative professio-nals, and the change of focus to understand the complex relationships involved in the development of a product or service. This will be done through the integration of online and offline learning methods. However, in order to understand the motivations (and lack of them) of designers to involve with sustainable design, there are several knowledge gaps to fill. Thus, research objectives are as follows:

- Objective 1: Find out if audio-visual materials enhance interest on sustainable design.
- Objective 2: Describe attitudes, feelings and motivations related to sustainable design.
- Objective 3: Understand which attitudes, feelings and motivations are involved in creative peoples' interest to practice sustainable design.

The rest of the present study is organized along these lines: Chapter II reviews literature about cognition, psychology, social networks and recommendation systems for educational purposes intersected with sustainable design; Chapter III outlines the objective, methods, results, discussion and conclusions of the first study, focused in the analysis of videos about sustainable design; Chapter IV describes the second study, aimed to develop a lexicon which includes feelings and other subjective evaluations of sustainable design; Chapter V recounts the third study, which develops and tests an educational intervention integrating videos and psychological techniques to foster interest in sustainable design; and Chapter VI will link the findings of all the studies, providing a general discussion and conclusions. Figure 1 summarizes the workflow of the research:

Figure 1. Research Workflow



CHAPTER II: LITERATURE REVIEW

"I miss aspects of being in the Arab world - the language - and there is a tranquility in these cities with great rivers. Whether it's Cairo or Baghdad, you sit there and you think this river has flown here for thousands of years. There are magical moments in these places."

-Zaha Hadid (2009)

3. THE HUMAN MIND AND THE ENVIRONMENT

3.1 Cognition Of The Environment

Some people might think first about advertisement or a fine car when they hear the word *design*. However, the environment can also be designed or incorporated in a product or service with a specific purpose. The importance of environment cognition is evolutionary (Chatterjee, 2011), as humans have focused in landscapes for thousands of years to improve their chances to survive. Its relevance is also pragmatic, when expectations of engagement with a real-life situation trigger the prioritization of meaning, content, and relation to the self (Cupchik, 2013). Moreover, the environment has an aesthetic importance.

The VIMAP model for art perception (Pelowski et al., 2017) integrates top-down factors of interaction with art. It can be applied to the interaction with a designed object that includes the environment in a salient way (e.g. the Japanese imperial garden) in order to understand the creation of meaning, associations and evaluations related to the environment from a human point of view. Table 1 summarizes the outcomes section of the VIMAP model.

Table 1. Outcomes of interaction with art (based in Pelowsky et al., 2017)

Outcome	Checks			Processing Mode	Phys./Behav. response	Affect/ Emotion
	Congruency	Self Relevancy	Need to Cope			
1. Default	High	Low		Detached/ Aesthetic	Low Arousal	- Little felt - Boredom, disinterest
2. Novelty, insight	Low	Low		Detached/ Aesthetic	- Increased skin conductance, decreased heart rate (novelty) - Increased heart rate variability (surprise)	- Pleasure, excitement, bemusement, tension, surprise, thrill - Confusion - Sublime (awe, fear)
3. Emotional resonance	High	High		- Inability to express emotion/ significance? - Pragmatic	- High arousal, increased skin conductance - Spreading activation - Sense of luminosity - Chills	- Felt and/or depicted emotion - Harmony, pleasure, absorption - Being moved
4. Negative	Low	High	Yes	- Meaningless or not understood	- High sympathetic arousal (fight or flight) - Fidget, talk to others, leave	Felt Negative Emotion

				- Pragmatic		- Confusion, Anxiety, Anger - Need to stop/leave - Disappointment (expert) - Nervous, shame, embarrassed, sad (lay)
5. Transformation	Low	High	Yes	Experience based interpretation	Sympathetic plus parasympathetic	- Self-aware - Aware of body - Need to exa-mine motives
				Pragmatic, then aesthetic	Parasympathetic latency period	- Confusion/Anxiety and Epiphany/Harmony - Epiphany, insight - Relief, catharsis - Happy, pleasure, wholeness, connectedness - Thrill - Sublime, awe?

In the example of the Japanese imperial garden, if the person visits this place frequently and the garden lacks self-relevancy (Default outcome), they will be bored. If the garden is a new experience but lacks self-relevancy (Novelty outcome), there will be some pleasure, excitement and confusion. If there is high congruency and self-relevancy (Emotional resonance outcome), the emotions will be positive and intense. If the person is not a fan of gardens (Negative outcome), the responses will tend to be of the automatic kind (fight or flight, but also criticize). Finally, if the garden is a new experience that has a high self-relevancy (Transformation outcome), it might have the power to transform the person views.

It should also be noted that if the outcome corresponds to Novelty, Emotional resonance and/or Transformation, a phenomenon known as place attachment may occur, particularly if the interaction with the environment increases in frequency. A distinction between physical-natural (e.g., landscape) attachment and social-symbolic (e.g., national identity) attachment should be made, as the first type was found to be a significant predictor of pro-environmental behavior while the second type was not (Scannell & Gifford, 2010; Kaida, 2015). Moreover, place attachment has a globalized dimension that can transcend geographic and social boundaries (Gurney et al., 2017), which might aid cooperation to foster environmental awareness and protection. This is why it is relevant to explore behavioral research related to the environment, which will be discussed in the following section.

3.2 Behaviours Related To The Environment

Behavioural theories related to human interaction with the natural environment can be integrated into the Goal framing theory by Dittmar (1992), as shown in Table 2:

Table 2. Integration of Goal Framing Theory by Dittmar (1992)

Goal	Environment's Value
Hedonic	Affect
Gain	Instrumental
Normative	Symbolic

Nature and other non-human living entities are mostly handled as instrumental, but it wasn't always this way. Ancient civilizations viewed nature as animistic and organic. It was science development in the sixteenth century (particularly in Europe) what fostered a view of nature as a system of particles moved by external forces, available for utilization (Boehnert, 2017). Merchant (2001) argues that Francis Bacon created the metaphor of nature as female and as a force to be mastered, controlled and submitted. In sum, current human behaviors towards the environment result from "a prior disorder in the thought, perception, imagination, intellectual priorities, and loyalties inherent in the industrial mind" (Orr, 2004), which involves individuals' way of thinking and institutions in charge of shaping the capacity to think.

Pro-environmental behaviours are prevented through several psychological barriers. Gifford (2015) identified 33, which can be summarized as limited cognition, ideologies, social comparison, costs, discredence, perceived risk, and the limits of behaviour. The consequences are many: loss of interaction with nature diminishes health and well-being benefits, attention, space perception, self-discipline, positive conduct, community connection, increases crime, and discourages positive emotions, attitudes and behaviours related to the environment, implying disaffection toward nature (Kaplan, 1995; Tzoulas et al., 2007; Reeve et al., 2015; Soga & Gaston, 2016; Repke et al., 2018). However, disaffection is also associated with more local information processing, while a greater connection to nature is associated with global information processing; and connectedness to nature lead to behavior when values associated with beliefs were activated (Schultz et al., 2004).

The relationship between the natural environment and social environment should also be noted, as human attitudes towards nature are affected by the strength and stability of human relations (Easterlin, 2012). Nevertheless, there is some evidence that biospheric value orientations are more determinant for pro-environmental behaviours than altruistic (human related) value orientations (De Groot & Steg, 2008; Cortes Lefranc, 2017).

Kaplan (2000) and Kaplan & Kaplan (2005) proposed the reasonable person model to foster pro-environmental behaviors, based on informational needs and its processing which can encourage meaningful action. Segmented social marketing approaches (e.g., Daamen et al., 2001; Verplanken & Holland, 2002; Abrahamse et al., 2007; Thøgersen, 2007; Markowitz & Shariff, 2012; Hine et al., 2014) have also been successful. This is independent from whether the human individual has a correct understanding of environmental science (Wolf & Moser, 2011; Hall et al., 2018). Moreover, motivated reasoning ostensibly polarizes individuals, compromising the adoption of pro-environmental policies (Hart & Nisbet, 2012). Role modelling and feedback about others behaviour foster pro-environmentalism as well (e.g., Lehman & Geller, 2004; Abrahamse et al., 2005; Schultz et al., 2007); while having more than one role model has a bigger effect in pro-environmental behavioral change (Sussman et al., 2013).

Based on the previous studies, it can be concluded that there is few research on context related to change in behaviour and attitudes towards the environment. Affective aspects have not been thoroughly researched (Steg & Vlek, 2009), and the studied behaviours tend to be general, e.g. separating waste, transportation choice, energy consumption in the house and support for policies.

3.3 Pro-Environmental Behaviours And Designers

Pro-environmental behaviours among designers have not been thoroughly researched. Ji and Amor (2015) provided evidence that design habits of sustainable design students change more than those of professionals, also finding a significant difference on personal norms between design students, faculty members and professionals. Ueda (2015) found that the main driver for Japanese industrial designers in eco-innovation was a technological approach through short-term strategies, companies and designers did not show interest in sustainable design educational initiatives, and that local community oriented pro-environmental activities were viewed as positive solutions. Also, Niedderer et al. (2016), discussed lack of time and evidence of effectiveness as the greatest obstacles for pro-environment behavioral change in the design process.

Taking on account that implementation intentions for behavioural change might be well suited for creative people because those "who manage to come up with creative integrations are more likely to meet their goals" (Gollwitzer, 1999), this approach should be given attention. Gollwitzer's implementation intentions are based on Ajzen's (1991) attitude–behaviour model, making people specify when, where, and how a behaviour will occur. Although it is unknown which psychological processes mediate behavioural commitment making (Lokhorst et al., 2013) there is a medium to strong effect size for the relationship between specific goal intentions and the performance of behaviour (Gollwitzer & Sheeran, 2006). Moreover, those who managed to change their behaviour through this technique were also faster when recognizing words describing critical situational cues; and implementation intentions inhibits automatic activation of stereotypical beliefs and prejudicial feelings (Gollwizer, 1999).

Most of the reviewed research has been conducted through self-reports in WEIRD (Westernized, Educated, Industrialized, Rich, Developed) countries. Therefore, a focus on inclusivity of non-WEIRD humans, living beings and landscapes in the design practice should be discussed in the following section.

4. TOWARDS AN INCLUSIVE SUSTAINABLE DESIGN

4.1. Theories To Embody Sustainable Design

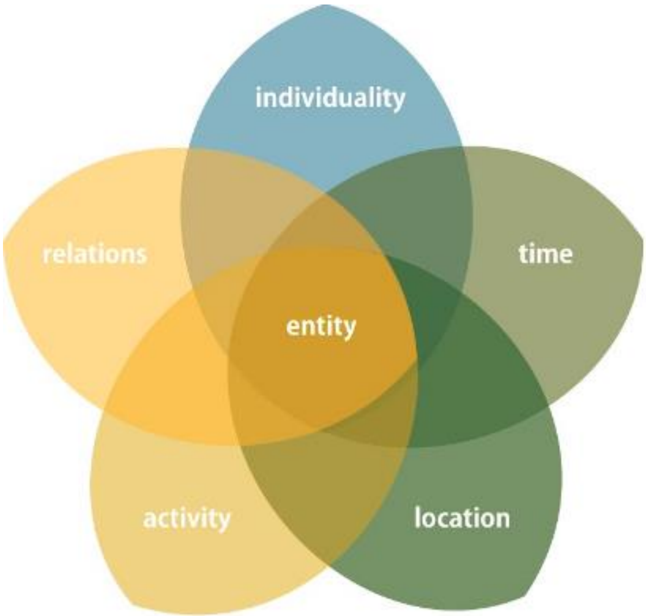
Ecological rationality proposes inclusive and holistic forms of reason that integrate the context on which we depend (Boehnert, 2017). This reasoning method would help to understand and manage the complexity of sustainable design. Regarding inclusiveness, the present research borrowed concepts from feminist technoscience (Asberg & Lykke, 2010). In particular, the focus of feminist technoscience on intersections between race, class, gender, science and technology; implications of context dependent knowledges; understanding agency, body, rationality, and the boundaries between nature and culture; and examining connections between knowledge and practice can provide a more comprehensive picture of sustainable design.

The application of feminist technoscience to design is called feminist speculative design, which focuses on using artefacts to provoke reflection on the privileges of one sector of the population while another is being oppressed. According to Martins (2014), such projects would "need to be shared, commented upon, questioned and criticized in order to be culturally relevant". If such concepts are extended to human relationships with non-human beings and the environment, we would get a *bio speculative design,* where "bio" would stand for "all life". However, research embodying the principles of bio speculative design requires operationalizing context while also taking on account emotional and other subjective factors, which will be discussed in the following sections.

4.2 Contextual Factors In Design

Context can be defined as information which helps to characterize the situation of a design object. Zimmermann et al. (2007) distinguish five context categories that determine the design space of context models, as shown in Figure 2:

Figure 2. Context categories based on Zimmermann et al. (2007)



Through the study of contextual information from a design object (called *entity* in the model), designers can develop products and services in an easier and more effective way (examples can be found in Zimmermann et al., 2005). The model aids the potential integration of culture, subculture, nationality, political and economic factors at individual and relationships levels. This could aid our understanding of how communities think, feel and imagine (Norgaard, 2011). The natural environment can be a part of the location category, a part of the individual environment, and a part of relations in the case of non-human living beings. All the factors in the model can be influenced through the value assigned to the environment and the frequency of contact with it.

4.3 Emotional Factors: Kansei As A Tool To Implement Sustainable Design

An emotion can be considered as an episode of interrelated, synchronized changes in the state of all or most of an organism in response to the evaluation of a stimulus event as relevant to major concerns of the organism (Scherer, 1987; 2001). Qualitative research can be aided by Kansei science through measuring and testing ways to change the emotional value of a product/service. Kansei is a word that includes sensitivity, sense, sensibility, feeling, aesthetics, emotion, affection and intuition among its meanings (Lee et al., 2002). However, the definition that best fits sustainable design is provided by Kuwako (Hasebe et al., 2010), who describes it as “an ability of sympathy between the environmental world and the self-body”. For example, through Kansei words, users are guided to express their affective needs, feelings, emotional states and moods, which in turn can be applied to design products and services that include economic, social and environmental values better.

Eco design related research (which has been mostly conducted in Northern Europe, the U.S., Australia and Japan) between late 1990s and early 2000s is focused in technology and ignores the user (Boks, 2018). Bouchard et al. (2010) compiled 147 references to link User Centered Design, Eco Design and Kansei; finding that the literature covered Eco Design methodologies and software, eco-feedback, behavioural steering, persuasive technologies, user modelling techniques, ergonomics, methodologies to measure subjective emotions, eco-user profiling and scenario analysis (which shares similarities with the contextual factors mentioned in the previous section).

Much of this work has remained on a theoretical level. One of the few practical applications of Kansei to sustainable design was the measurement of behavioural change related to sustainable products (Shih & Chang, 2012). Thus, the intersection between the study of feelings towards the natural environment and the development of products and services is still underdeveloped. Bouchard et al. (2010) only found two papers relating Kansei with eco design.

It is important to note that emotions are not tied to the product or service, but to the interaction between them and their context (Hedman, 2014). However, there is some evidence that emotional states could enhance pro-environmental behaviors through the design process. It is believed that humans have a deep desire to live a *good* or *meaningful life*, using their skills to belong to and serve a larger purpose (Seligman, 2004). Markowitz and Shariff (2012) discuss the role of positive emotions like gratefulness, hope and pride versus negative emotions like anxiety, guilt and shame in taking action against climate change, giving preference to positive emotions.

In contrast, the effect of negative emotions has not been thoroughly researched in empirical literature. Disgust, purity and sanctity are suggested as effective emotions for pro-environmental change (Gutsell et al., 2012). This makes sense for conservative or resistant to change audiences, which tend to prioritize the past instead of the future. Moreover, sadness tends to foster a problem-solving mind set (Schwarz et al., 1991), which might have appeal for creative people.

The psychological aspects underlying the interaction of non-human nature and creatives have been extensively revised in this section. As societal structures (particularly education and communication) also are relevant factors affecting the diffusion of sustainable design, they will be discussed in the following section.

5 THE DIVERSIFICATION OF COMMUNICATION CHANNELS AND THEIR IMPACT IN EDUCATION

5.1 Teaching Sustainable Design In The Internet Era

University rankings are based on evaluations of teaching, research, international output, perceived reputation and other factors. They are available at global, national, regional, and study subject levels. On the case of design schools, around half of the top universities were located in the U.S. and UK (Quacquarelli Symonds Limited, 2016; Times Higher Education, 2016). The main difference between these two rankings is that the first has more presence of Australia and Spanish speaking countries. However, an important factor that is not taken on account in traditional university rankings is sustainability.

The University of Indonesia proposed to integrate infrastructure, energy and climate change, waste management, water management, transportation and sustainability related education to conform the UI Green Metric World University Ranking on Sustainability. If universities are ranked according to sustainability related education, US still is the top country; closely followed by Thailand, Spain and UK (Integrated Laboratory and Research Center [ILRC] of the University of Indonesia, 2016). It should be noted that, while former rankings contain data from 900 and 1,200 universities respectively, the Green Metrics counts with voluntary participation of only 407 institutions (ILRC of the University of Indonesia, 2016).

Universities role has been enriched and diversified through various communication channels. For example, websites, virtual libraries, document repositories, etc., help building a university's reputation online. However, the difficulty to underpin academia related activity to sustainable design should be taken on account.

The Designers Accord (2013) reported that around 20% of their participative community is related to academia. There are several centers of sustainable design in universities around the world, and mobility programs enable some students to take part in them and have contact with other cultures (e.g. Global Innovation Design in Keio University and Global Studio in the University of Sydney). Moreover, according to The Autodesk Foundation (2015), there are around 150 universities with sustainable design programs in the U.S. alone. Nevertheless, data on sustainable design in other countries (particularly non-WEIRD countries) is less specific.

The internet has been employed to diffuse sustainable design particularly when it is not structured as a fully fleshed course, starting through closed communities (e.g. DESIS network and LeNS). These communities are assessed by experts from diverse design fields located in several countries, including non-WEIRD countries. In contrast, some professional organizations with web presence like Renourish and the Designers Accord have an open source vision, but are managed in WEIRD countries.

Proposals to integrate a curriculum of sustainable design education involving academia and other stakeholders have also been released in internet. Two web platforms were BaSiC initiative and DEEDS (Blincoe et al., 2009). Both were university based and are currently unavailable. The EcoDesign Foundation in Sydney had the ambition of establishing a new platform for all higher education (Tonkinwise, 2013), but this organization merged with the Society for Responsible Design and there has been no further discussion on the topic.

Apparently, the only thriving internet-based platform is PublicInterestDesign.org, which later became Impact Design Hub. It is a private initiative related to the American company Autodesk, more focused on being an information directory than in active diffusion or education. In sum, specific activities involved in knowledge/teaching of sustainable design through internet at a global level have had a limited impact and remain unclear. However, this subsection mostly reviewed web 1.0 resources. More interactive sources will be discussed in the following section.

5.2 Social Networking Sites And Their Adoption In Academia

The transition from web 1.0 (*Read-only*), through web 2.0 (*Participative*) towards web 3.0 (*Responsive in real time*) also affected education at the university level. One of the most remarkable developments of the web on recent years were Social Networking Sites (SNS), which are services that store personal and relational data to facilitate communication and information sharing. According to a report by Kemp (2016), 31% of the total world population has an active social media account, with East Asia, South East Asia, West Europe, North America and South America having higher percentages of active accounts.

In social networks, inbound groups have more influence on attitudes, norms, behaviour and decisions than messages received from outsiders (McKenzie-Mohr, 2000; Christakis & Fowler 2009; Cialdini 2009). In network theory, this concept corresponds to small-world networks, which reflect particular perceptions or Kansei (Shiizuka, 2013). Therefore, beyond their entertainment and informational features, social networks are relevant for academic usage. For example, Moran et al. (2011) found that the rate of SNS adoption on university faculty was over 90% in courses they're teaching or for their professional careers outside the classroom, being YouTube and Facebook the most cited. Also, Orduña Malea and Ontalba Ruipérez (2013) confirmed the correlation between total external links and links that come from social platforms among Spanish university websites.

Within social networks, Video Networking Sites (also called Video Sharing Sites or VNS) are easy-to-use integrated platforms focused on uploading, managing, sharing and watching videos. Quick conversion of video formats, tags and embeds are distinctive characteristics of these sites as well. By 2013, Netflix and YouTube accounted for over half of internet traffic if measured in bytes (Kholeif, 2016).

Open Video Networking Sites have been widely explored in relationship with education (Snelson et al., 2012). For example, YouTube videos have been employed for health education (Burke & Shonna, 2008), architecture (Ham & Schnabel, 2009) communication (Juhasz, 2011), and sciences (Eick & King, 2012), with positive results.

As it can be inferred from previous studies, YouTube has been more researched than any other VNS. According to Cheng et al. (2013) YouTube videos have strong correlations with each other, conform small-world networks; tend to last 10 minutes; and rating (liking) and comments have been increasing over time.

An analysis on more than 20 million YouTube videos uploaded the same year found that social sharing tends to widen the geographic reach of a video (Brodersen et al., 2012). Also, Thelwall et al. (2012a) assessed the impact of YouTube videos tweeted by academics, realizing that the audience for typical academic videos tends to be small, where typical means a regular lecture. However, given all their characteristics, YouTube videos have a high potential to be eco feminist speculative design artifacts.

According to the reviewed literature in the present section, a mix of universities from WEIRD and non-WEIRD countries might be leading the sustainable design academic video network in YouTube. Nevertheless, literature about universities and their presence on the internet (Lee & Park, 2012; Cybermetrics Lab of the Spanish National Research Council, 2013; Barnett et al., 2014) suggests that WEIRD countries might be more salient. The interaction with videos related to universities is expected to be lower than with entertainment-oriented videos as well. However, the reviewed literature focuses on quantitative measurements. To integrate a qualitative dimension for the present research, emotions in the internet context will be discussed.

6 THE STUDY OF SUBJECTIVE INFORMATION IN THE CYBERSPACE

6.1 The Psychology Behind Text Analysis

When recalling emotions after a fact, humans tend to rely on more generalized beliefs rather than on episodic memory (Robinson & Clore, 2002ab). That is why it is important to consider research methods beyond self-reports. The usage of text to link language with behavioural and self-reported measures of personality, social behaviour or cognitive styles is not new. Both quantitative and qualitative methods have been applied in the social sciences (for a review, see Lacity & Janson, 1994). Another example is Gries and Divjak (2009), who analyzed the objectivity of text analysis by observing how conventional the terms are. It is also possible to create behavioural profiles based in writing, as stated in Hanks (1996), who emphasizes the utility of large data quantities.

Words matter for message framing as well. For example, using terms that involve the word *global* helped engage people in conversations about global understanding, social justice and personal social responsibility (Shultz, 2010). Regarding pro-environmental behaviours, wording choices affected public risk perceptions about climate change and support for mitigation policies (Hine et al., 2016), although they did not have a uniform effect across the population. However, the study of emotions reflected in online texts is the subject of another specific field which will be discussed in the next section.

6.2 Cyberemotions

Cyberemotions is the study of emotional expression in the cyberspace. One of the first analysis in this field was conducted by Rice and Love (1987), who argued that computer-mediated communication allows the exchange of emotions despite the inherent absence of non-verbal communication parts. Information exchange in the Internet is thought to be more emotional than offline communication (Sobkowicz & Sobkowicz, 2010), partly due to an online disinhibition effect (Suler, 2004) originated in the anonymity that this type of mediated communication provides. It is also possible to find patterns of moods according to day and season across cultures (Golder & Macy, 2011).

Rather than focusing on a user's emotional states, social networking sites studies focus in the emotional charge of the link (relationship) the user has to other users, according to attachment theory (Trier & Hillman, 2017). Weak positivity is the most common sentiment found in comments on online videos, while negativity is associated with the densest discussions (Thelwall et al., 2012b). Also, commenters tend to be more emotional if the speaker is a woman (Tsou et al., 2014).

Studying community driven emotions adds another layer of complexity. Researchers have employed post-hoc analysis or modelling of valence related to memes (Leskovec et al., 2009), massive multiplayer online games (Szell et al., 2010), blogs (Mitrovic & Tadic, 2011; Alvarez et al., 2015), blogs and forums (Chmiel et al., 2011), and chats (Garas et al., 2012). In general, emotional content tended to favour positive emotions; and the link between emotions and text was usually weak due to the properties of automated text analysis, although it was better than in MRI based studies (Kuster & Kappas, 2013).

It is also possible to uncover implied sentiment of nouns in a particular context (Zhang, & Liu, 2011). Holyst et al. (2017) found that the preferential growth of mono-emotional clusters can be described by a power law; the number of possible emotional states does not influence a critical time needed for the emergence of a mono-emotional comments thread; and that group members representing minor emotions display larger mutual interactions and tend to be more clustered than the representatives of major emotions. This implies that people will likely comment in long threads and that any emotion can become dominant in a thread.

Another useful concept in the study of online emotions is borrowed from thermodynamics. Bailey (1983) introduced the social entropy theory (SET), which states that in neutral and positive emotion scenarios, entropy tends to be higher towards the end of the comment interchange, while in negative emotion scenarios, entropy tends to be lower. However, the interactions always will aim to reach a state of equilibrium. Sienkiewicz et al. (2017) employed agent-based computer models to predict real conversations, showing that: a) in individual threads, users that are more active in a specific thread tend to express more negative emotions and seem to be the key agents sustaining discussions, making longer threads more negative; and b) only the threads where a certain emotional potential is present can evolve into a full discussion.

García et al. (2017) used Brownian agents applying Russel's representation of core affect, conceptualizing emotions as short-lived psychological states. The results of this study were replicated based on real life social networks data by Tadic et al. (2017), and Trier & Hillman (2017). The patterns can be compared to patterns of natural selective attention (as in Bradley & Lang, 1999); and the graphic which represents the spread of positive emotions looks like a tall tree, while negative emotions look like pot plants. In sum, what can be inferred from these studies is that it is easier to predict and model extreme emotional states than mild ones, and that even a small amount of negative emotions might be an important indication of the conversation dynamics.

6.3 Cyberemotions In Context And Graphical Representations

Context sensitive methods to measure sentiment polarity were proposed by Bahrainian et al. (2014), and Rathod and Deshmukh (2016). However, most of the literature on detection of emotions involving context employs tweets (short text) as unit of analysis. As for languages, there is a positive bias in English and Spanish word usage, while negative valence communication tends to carry more information (García et al., 2012).

Although automatic text analysis has been employed for decades, attention to graphical representations which accompany written communication has only increased in recent years, due to their rising importance in terms of emotional expression. Emoticons are considered as a set of commonly used symbols combined to convey sentiments. Examples include :) and T-T. It is considered that emoticons were born in 1982, when Scott Fahlman proposed to write :-) and :-(to distinguish serious posts from jokes (Fahlman, 2018).

On the other hand, emojis include emoticons and other graphical representations of animals, plants, objects and actions (e.g. 🐓, 🌸, 🍕, 🏃). Emojis were created in 1999 by Shigetaka Kurita for the mobile phone operator NTT Docomo, becoming widely used in the world when Apple included them in their messaging app in 2011 (Morley, 2018). In the present study, all these communication-oriented objects will be called *graphical representations*. Their relevancy for communication among creative people (who are trained to code and decode visual information) makes necessary to incorporate them to the analysis.

Most of the software for automatic text analysis ignores graphical representations, sometimes being incapable of handling even common emotional features like the exclamation mark (*!*). In the case of sentiment analysis, only a few studies incorporate graphical representations (Novak et al., 2015). However, there still is uncertainty on how much congruency between a graphical expression and a specific emotion can exist, as researchers are not sure if emotions in the internet context are experienced and expressed in a universal way.

This is a debated question that can be traced back to the study of emotional expression with traditional methods. A survey with respondents from 27 countries found that different cultures have similar subjective appraisals of emotion-related physiology (Wallbott & Scherer, 1988). However, when asking for more open descriptions of emotional responses to Northern and Southern Europeans, sadness elicited different answers (Scherer et al., 1986). Another study also found that while American respondents had similar emotional responses to Europeans, Japanese respondents had fewer physiological reactions (Scherer et al., 1988). Finally, a survey where respondents from Germany, Mexico, Poland, Russia and the U.S. were asked to identify the part of their body where they felt specific emotions showed several differences across cultures (Hupka et al., 1996).

The mediated experience of social media adds an additional layer of complexity in the expression of human emotion. Briscoe et al., (2014) found that the credibi-lity of a message is influenced by sentence complexity, sentiment and emoticon usage, being perceived as less deceptive if it involves a high number of the aforementioned characteristics. Also, users write significantly more and faster when sharing an emotional episode (Skowron et al., 2017).

Emoticons tend to emphasize the emotion reflected in words as well. Some studies propose universal meaning for emoticons (Gruzd, 2013), while others state the opposite (Park et al., 2013). There also have been attempts to create databases for graphical representations including their emotional valence by Novak et al. (2015,) and Campero et al. (2017). In the first case, some graphical representations are missing and in the second, the researchers focused only on emoticons.

According to studies reviewed in this section, the conclusion is that the amount and way of expression of some emotions through graphical representations might be nearly universal, while others will tend to vary. This might be partly due to the wide spread of emotional labels based on WEIRD countries shared cultural features. Meanwhile, differences in graphical representation meaning and usage might be related to the highly diverse cultures influencing writing systems and languages particularly in Asian and Southern countries. Thus, context is relevant for the emoticons meaning (Kelly, 2015).

The role and expression of emotions in cyberspace was revised in this section. In order to develop an adequate educational intervention from an online perspective, technological aspects related to recommendation systems will be reviewed in the next section.

7 RECOMMENDATION SYSTEMS

7.1 Structure

A recommendation system is a program that ranks and lists items, and/or predicts how much the user might prefer each item (based on Shani & Gunawardana, 2011). It works in two main phases, profiling (of either users or items) and matching between users and items.

The methods through which recommendation systems manage data can be classified in three types. The first one is collaborative filtering, which employs user's ratings to match a user with items which share similar characteristics. An example can be a travel webpage that ranks touristic destinations according to user's preferences (e.g. Ellouze et al., 2017). Content-based systems are focused in the items attributes. The third type is social or knowledge-based systems, which manage data from more than one user at a time. An example can be an e-learning platform that analyses the users' behaviour in the platform and other social networking sites to quantify the amount of data and interaction the users generate in relationship with the topic they are studying, and also to classify the users according to broad behavioural patterns (Hlioui et al., 2017).

Adomavicius and Tuzhilin (2005) discussed areas of improvement for recommendation systems, including users and items understanding, incorporation of contextual information, multicriteria ratings, and more flexible and less intrusive recommendations. Thus, some latest approaches for recommendation systems incorporate text-based analysis (e.g. Zhang et al., 2013), or use a broad selection of variables (e.g. Schmitt, 2017; Ziemba et al, 2017). Karatzoglou et al. (2010) and Shi et al. (2012) employ Tensor Factorization to incorporate context in collaborative filtering.

Data quality is another relevant aspect to understand users, items and their context. El Sibai et al. (2017) proposed to evaluate data quality according to the considerations in Table 3. Particularly in the case of multimedia items which are often used for online education, believability, reputation, objectivity, relevancy, value added, ease of understanding, interpretability, accessibility and privacy are characteristics to be taken on account. It is also noted that contextual information, flexibility and privacy have been given limited priority by researchers.

Table 3. Data Quality Dimensions based on El Sibai et al. (2017)

Intrinsic Dimension	Contextual Dimension
• Accuracy: difference between the value stored in the database and the real value that the data aims to represent • Believability and Reputation: degree to which the user considers the data correct and trustworthy	• Amount of data • Completeness: ratio of the size of the data registered in the database and the size of real-world data • Relevancy: satisfaction degree of the user's needs and tasks • Timeliness: age of the data

• Objectivity: degree to which data is equitable and unbiased	• Value added
Representational Dimension	Accessibility Dimension
• Concise representation: degree to which the data structure is suitable to the data itself • Ease of understanding: degree to which the semantic relation between the different information is understandable by the user • Interpretability: the degree to which the data is clear, simple and appropriate for the user • Representational consistency: degree to which the data are compatible with previous data	• Accessibility: the probability that a user's query is answered within a specific time range • Access security: privacy

The present section has focused mostly on the nature of users and items in recommendation systems. However, how ratings and the relationship between variables is calculated also impacts the system performance. Therefore, the next section will review this factor in detail.

7.2 Algorithms

An algorithm is a set of rules to follow when computational calculations are performed. There are five broad types of algorithms (based on Binitha & Sathya 2012; Yera & Martinez, 2017), described as follows:

- Markov models: stochastic processes that produce the sequence of observed symbols (Rabiner & Juang, 1986), based on complex probabilistic models.
- Bayesian approaches: processes that "learn" patterns by using data from similar target users. They can also be based in statistical models. In particular, Euclidean Distance and Naïve Bayesian classifiers have been widely applied to recommendation systems.
- Bio inspired approaches: they mimic an aspect found in nature.

- Ecological algorithms: approaches based in the interaction of one or more species and its environment. In particular, Invasive Weed Colony Optimization has been utilized for recommendation.
- Genetic algorithms: approaches based on evolutionary principles such as natural selection and survival of the fittest, which are mainly used for data clustering and to aid user-based models (Bobadilla et al., 2013). They have been applied to e-learning (Binitha & Sathya, 2012).
- Neural networks: approaches that "learn" patterns through previously collected data. They are composed of aggregates of regularly spaced circuit clones (called cells), communicating with each other directly only through their nearest neighbors (Schalkoff, 1997). Neural networks attempt to mimic the human brain.

- Fuzzy logic: processes that model real world concepts which cannot be represented in precise ways, where elements have a degree of membership into a given set. The application of fuzzy logic to recommender systems has been mostly focused in item profiling through tags and rates. Trung et al. (2013) modelled fuzzy propagation for opinion mining, providing evidence of a relationship between specific sentiments and topics.

The YouTube recommendation algorithm is assumed to be based on neural networks, which model implicit feedback to provide fresh, time consuming content at a large scale (Covington et al., 2016). However, the structure of social networks has been shown to lead to echo chambers, particularly in the case of divisive topics (Bakshy et al., 2015; Barbera et al., 2015). Although researchers argue that indivi-dual choices have a stronger effect than algorithms, the impact of advertising and propaganda posing as information in a video should be noted. Recommendation algorithms have often been fooled to fuel harmful content, as political activities in the American continent and Spain have shown (Lewis, 2018; Cardenas et al., 2017). All of this stems from the conception of artificial intelligence as a servant of corporativism (Agar, 2003). Thus, alternative ways to manage YouTube's content through a recommendation system, enhancing it for educational purposes, should be explored.

8 EXPECTED RESULTS

Given the literature review, social networks (particularly YouTube) have characteristics that make them attractive among education related actors, can transcend geographic and social boundaries, and count with small world structures that may aid cooperation in specialized fields. This enables the study of design-related communities without requiring self-reports, through a lens of eco feminist speculative design. Thus, it is expected to uncover the status of sustainable design particularly related to education through YouTube videos. It is expected to find universities mostly from the developed world leading such communities. The interaction with education related videos is also expected to be lower than with entertainment-oriented videos.

Social network analysis methods might be effective to uncover affective and other subjective aspects related to sustainable design, besides detailing the context in which it is practiced. It is also expected to uncover thoroughly why creative people do not adopt sustainable design through negative affect, attitudes and behaviours expressed in comments made in the videos. More interconnection with other YouTube users is expected in non-WEIRD countries, while egoistic concerns might be predominant in WEIRD countries, according to their levels of collectivism (Jones, 2007). Weak positivity in comments can be expected, and based on Kuster and Kappas (2013), the cohesion between emotional measures should be moderate. Also, the amount and expression of some emotions through graphical representations might be nearly universal, while others will tend to vary.

It is expected to advance recommendation systems by addressing areas like contextual information, flexibility and privacy using real world data. Finally, an educational intervention integrating environmental and social psychology methods is expected to be more effective than a technological intervention alone.

CHAPTER III: A SOCIAL NETWORK ANALYSIS ON SUSTAINABLE DESIGN RELATED YOUTUBE VIDEOS

"Knowledge is to be shared among the collective; it is not property nor it is secreted away."
- María Rogal (2015)

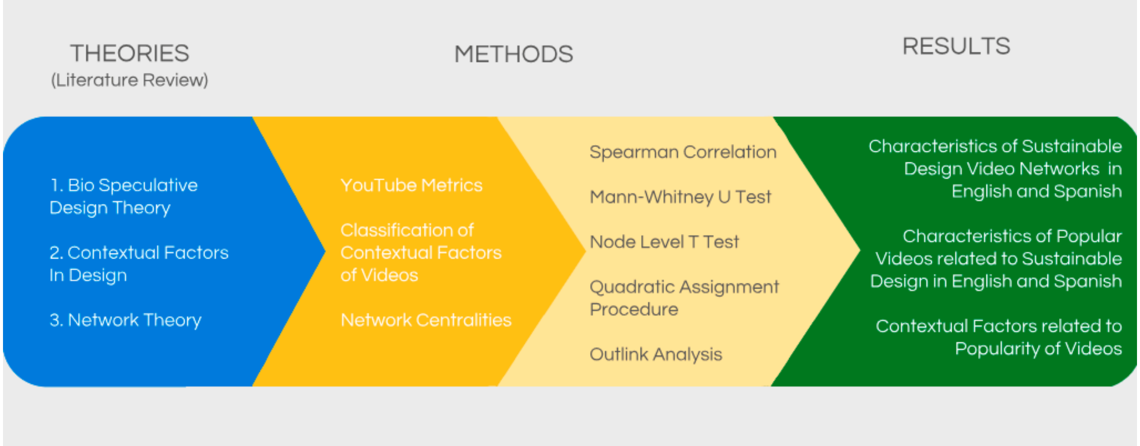
9 OBJECTIVES

According to the gaps found in previous literature, this chapter aims to answer the following questions:

1. Which are the characteristics of the sustainable design YouTube video networks?
2. Which are the characteristics of the most popular videos?
3. Which contextual factors are related to the videos' popularity?

To answer these questions, the following workflow will be implemented:

Figure 3. Workflow for Social Network Analysis on YouTube Videos



10 METHODS

10.1 Webometrics And Social Network Analysis

Webometrics is a technique to visualize SNS communication. It is defined as "the study of web-based content with primarily quantitative methods for social science research goals and using techniques that are not specific to one field of study" (Thelwall, 2009, p.6). Webometrics is combined frequently with social network analysis (e.g. Kane et al., 2012) because this technique lets us examine relationships and communication flows. A network is a set of nodes and ties, where a node represents an entity (e.g. a YouTube video) and a tie represents a link. In the case of YouTube, this link goes to a related video, which tends to be featured in the recommendation area of the YouTube page and is based on viewing patterns, reactions (clicks on *favorite*, *like*, or *dislike*), users' playlists, etc.

Several measures known as network metrics or centralities can be calculated to uncover the relationships structure between videos, and the impact that relevant videos may have on the overall network, as described in Table 4:

Table 4. Network Centralities and their Descriptions

Centrality name	Description
Connected components	Subgroups of nodes that can be reached from every other node in the group.
Density	Total number of ties divided by the number of all possible ties that can exist within a network.
Diameter	Average of the maximum distance between the nodes of a network.
Modularity	The strength of the division between subgroups in a network.
Path length	Average of the distance between the nodes of a network.
Betweenness	Number of shortest paths that tie other nodes in the network by passing through a specific node.
Closeness	Average number of steps a node requires to access all the other nodes in a network.
Clustering Coefficient	Measure of how close is a node to be part of a group.
Local Clustering Coefficient	Measure of how close is a node to be part of its local group.
Degree	Total number of ties a node has with other nodes.
Indegree	Number of ties directed to a node.
Outdegree	Number of ties a node directs to other nodes.
Eccentricity	The maximum distance of a node to another node.

10.2 Operational Definitions

The first step of the analysis was to select the keywords that would be used to collect YouTube video data. Chinese, English and Spanish were targeted as preferred languages for the keywords, as they are the most spoken languages in the world. Google Trends was used to compare the most common terms used to search sustainable design products and services. Although *eco design* is the correct term according to the ISO Norm 14006, *green design* and *sustainable design* were also frequently searched terms. As the analysis intends to also target academia related videos, the words *university* and *lecture* were considered. Thus, a total of 6 composed keywords per language were structured (shown in Table 5).

Table 5. Composed Keywords for Sustainable Design

Chinese	English
• 生態+設計+大學 • 綠+設計+大學 • 可持續+設計+大學 • 生態+設計+講座 • 綠+設計+講座 • 可持續+設計+講座	• Eco + Design + University • Green + Design + University • Sustainable + Design + University • Eco + Design + Lecture • Green + Design + Lecture • Sustainable + Design + Lecture
Spanish	
• Eco + Diseño + Universidad • Diseño + Verde + Universidad • Diseño + Sostenible + Universidad • Eco + Diseño + Curso • Diseño + Verde + Curso • Diseño + Sostenible + Curso	

10.3 Data Collection And Filtering

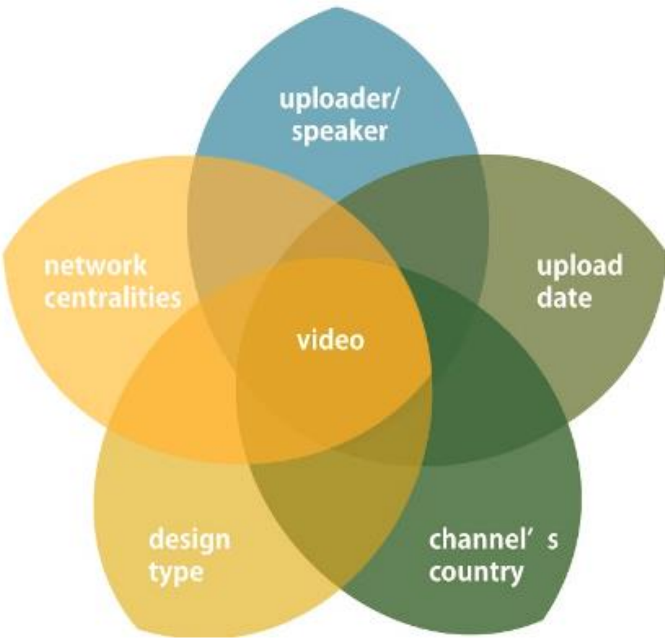
A set of scripts for the YouTube API v3 called *YouTube Data Tools* (Rieder, 2015) was employed to collect video data. The module of Video Network contained in the tools extracts videos data starting with a query (the keywords), or one or more video IDs (identifiers assigned by YouTube which can be found in the video link after the syntaxis *watch?v=*). On the present study, the first option with keywords was employed to obtain a file in cvs format. This file is composed by two sections: a video list with the video ID, label (title), iseed (crawl depth), seedrank (crawl priority ranking), published date, channel, category, number of views, number of likes, number of dislikes and number of comments; and a list of related videos. In other words, it contains information on the nodes (videos) and their links. The file can be read with the Gephi software (Bastian et al., 2009) to perform network analyses and create data visualizations.

Video sampling was conducted in November 2015. The sample of videos was composed by 9 data collections per query, making a total of 54 data collection points for each language. Each collection point extracted 500 videos taking on account relevance to the keywords. The resulting video files were appended into one for each language. Repeated video IDs were discarded and the most recent information on a given video ID was kept. Videos on the English and Spanish dataset were watched to discard any sustainable design unrelated materials. 2,452 English videos were considered as related to sustainable design from a total of 4,537; while 1,076 Spanish videos were considered as related to sustainable design from a total of 3,753. 3,623 Chinese videos were put on hold, as a coder with Chinese language ability was not available.

10.4 Classification Of Videos

Figure 4 shows the proposal of a model for online video's context based on Zimmermann et al. (2007). On the present study, the entity (also called design object) was considered as a video; individuality was considered as uploaders and speakers of the video; time was considered as the date of video upload; place was considered as the country's channel where the video was uploaded; activity was considered as the design type shown in the video; and network centralities were considered as relations.

Figure 4. A model for context in VNS



Based on the model, English and Spanish videos were classified according to country, design type, uploader and speaker, besides whether they had a relationship with universities or not. The country was found in the video's description, the YouTube channel's Home page, the channel's About page, the last part of the webpage link (e.g.*www.nikkotown.jp*), or by visiting the institution's webpage. If the speaker of the video was also the uploader and they disclosed the country where they live, that was also considered as the country. If it was not possible to determine the country of the video, it was classified as *Undisclosed*. Spain included Islas Canarias. UK included England, Northern Ireland, Scotland and Wales; while Ireland was considered as a separate country. US included Alaska, Hawaii and Puerto Rico.

Design type describes the type of sustainable design featured in the video. Each video was classified into up to two types of design (e.g. multidisciplinary/productdesign, webdesign/landscapedesign). Types of design are shown in Table 6:

Table 6. Design Types and their Descriptions

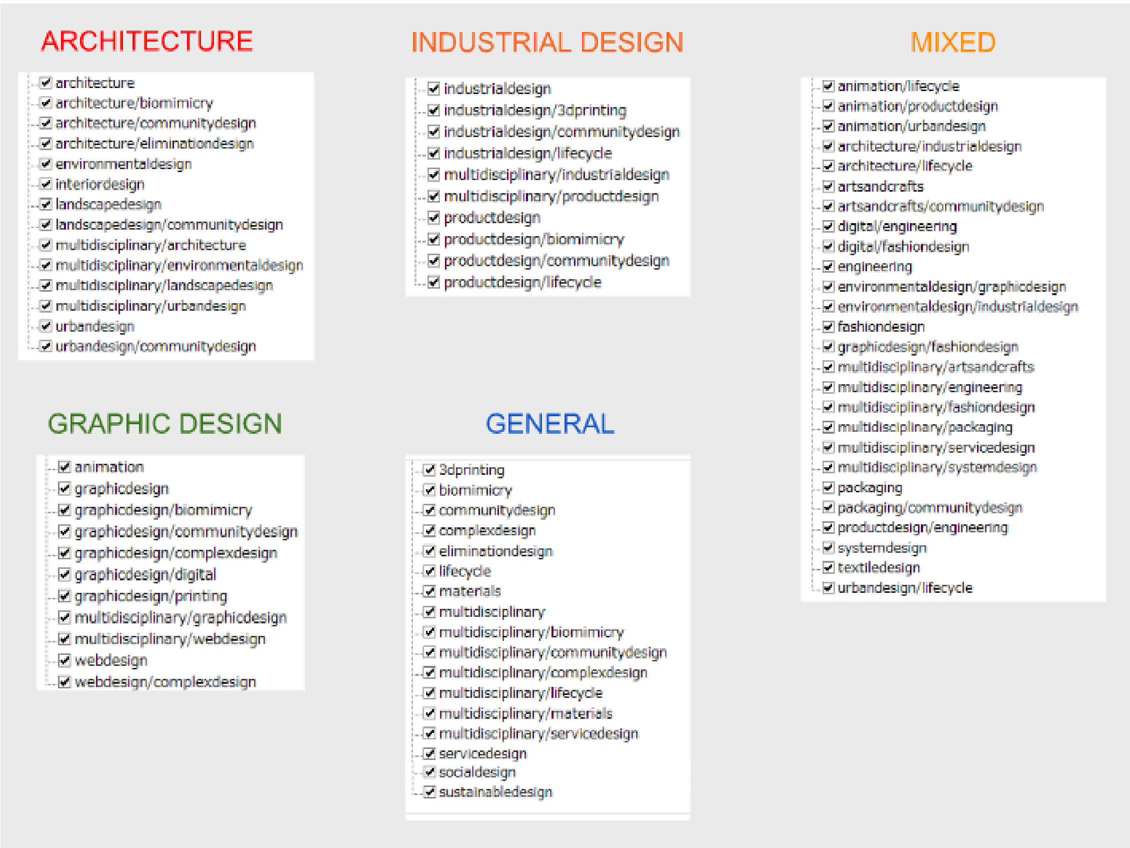
Design Type	Description
3dprinting	Process to synthesize a three-dimensional object.
animation	Process of making the illusion of motion or change. Includes 2d animation, 3d animation, stop-motion animation, etc.
architecture	Process of planning, designing, and constructing physical structures (mostly buildings).
artsandcrafts	Design and creation of products mainly by hand. The products can be inexact copies.
biomimicry	Also called biomimetics, it is the imitation of models, systems, and elements of nature.
complexdesign	Design of more than one system.
communitydesign	Also called participatory design, it includes the users in the ideation and design processes.
digital	Branch of graphic design that uses electronic devices to create graphics for the web, television, and portable electronic devices.

eliminationdesign	Type of design that considers which parts of a process/product is unnecessary.
engineering	Construction of structures and systems with an emphasis on physics and mathematics. Examples include civil, industrial and mechanical engineering.
environmentaldesign	Branch of architecture that takes on account surrounding areas.
fashiondesign	Design of clothing and accessories like shoes and bags.
graphicdesign	Visual communication and problem-solving through typography, image, color and 2D space.
industrialdesign	Design of products intended for large quantities of production with machines.
interiordesign	Branch of architecture that concentrates on the interiors.
landscapedesign	Design that bridges the nature and architecture of a specific place, including gardens.
lifecycle	Design that considers the entire lifecycle of a product, from materials and conception, passing through production, until its disposal.
multidisciplinary	Design strongly aided by disciplines not considered as design disciplines (e.g. chemistry, economics).
packaging	Design of enclose and/or protection for products.
printing	Process for reproducing text and images using a template.
productdesign	Branch of industrial design that develops new products.
socialdesign	Also called social impact design, it focuses on design as a social change agent (e.g. poverty reduction, health improvement).
sustainabledesign	Theory of sustainable design. Design that involves architecture, industrial design and graphic design together.
servicedesign	Planning and organizing of people, communication and material components of a service/experience.
systemdesign	Process of defining the components, modules and flows for a system.

textiledesign	Design of surface and patterns for fabrics.
urban design	Process of designing neighborhoods.
webdesign	The production and maintenance of webpages.

Next, design types were classified into five main design areas (Figure 5). The mixed area was comprised by design that does not fit into the other main categories (e.g. engineering), and by combinations of two design types that correspond to other main areas (e.g. animation/urbandesign, where animation belongs to graphic design and urban design belongs to architecture). As for the general area, it comprised sustainable design theory and design that integrates architecture, graphic design and industrial design together.

Figure 5. Design Types Comprised into Design Areas



Uploaders and speakers were classified according to gender. Self-perceived gender can be more diverse, but as there is no way to know in which gender they identify themselves only by watching the videos, speakers were classified according to physical and name features in female, male and other.

Uploaders were also classified based on the video's content, description, the YouTube channel's Home page, the About page, or by consulting the link to the webpage or the social media channel (if available). A description of the uploader types can be consulted in Table 7. It should be noted that the present study categorizes artisans and engineers as designers.

Table 7. Areas and Types of Video Uploaders

Business Area
• company • business director: one or more male directors. • business wdirector: one or more female directors. • business employee: one or more male employees. • business wemployee: one or more female employees.
Designers Area
• designer: one or more male designers. • wdesigner: one or more female designers.
Education Area
• educationinstitution: institution outside university that provides education, talks, workshops, etc. (e.g. art galleries, museums, foundations, forums, networks, associations, e-schools, high-schools, elementary schools, design collectives). • nonprofit: any education related organization that describes itself as non-profit.
Events Area
• award: design award. • event: events like live competitions (e.g. Shell eco-challenge).
Government Area
• government: institutions like city halls, embassies, Ministry of Technology, etc.
Media Area
• media: internet or paper-based news, magazines, etc. • journalist: one or more male journalists. • wjournalist: one or more female journalists.

People Area

- citizen: one or more male persons.
- wcitizen: one or more female persons.

Professors Area

- professor: one or more male university professors.
- wprofessor: one or more female university professors.

Research Area

- researchinstitute: institute outside the jurisdiction of a University.
- researcher: one or more male researchers.
- researchers: group of male and female researchers that do not disclose belonging to a specific institution.
- wresearcher: one or more female researchers.
- research director: one or more male directors.
- research directors: male and female directors.
- research wdirector: one or more female directors.
- research employee: one or more male employees.
- research employees: male and female employees.
- research wemployee: one or more female employees.

Students Area

- student: one or more male students.
- students: male and female students.
- wstudent: one or more female students.

Undisclosed Area

- undisclosed: uploaders that were not identified as any of the other types.

University Area

- universities: in case a YouTube channel is jointly used by several universities.
- university: includes undergraduate colleges, graduate colleges, and research institutes that specify their affiliation (or location) within a university.
- university employee: one or more male employees
- university wemployee: one or more female employees.

Attention was paid to hierarchy of nominations, especially when an uploader could be classified into two or more types. The order of the hierarchy was: professor > student > designer > researcher > director > employee > celebrity > citizen. Therefore, if an uploader was disclosed as a professor but also as a company director, they were labelled as professor.

Speakers were considered as the person who talks and/or is mainly featured in the video (e.g. shown designing). Usually, the speaker introduced themselves in the video content or in the video description. The YouTube channel's Home page, the About page, webpage and social media channel were also reviewed. Videos that featured more than one speaker were coded with one label per speaker. Thus, if a video showed a designer and a female student discussing sustainable design, the speaker classification was *designer/wstudent*. On the case of journalists and presenters, they were not counted as speakers unless they were hosting the video (e.g. a journalist's YouTube channel uploading their interviews or programs), or if they engaged in a dialogue with the other speakers. As it can be inferred, types of speakers and uploaders are different, as described in Table 8:

Table 8. Areas and Types of Video Speakers

Business Area
• business director: one or more male directors. • business directors: male and female directors. • business wdirector: one or more female directors. • business employee: one or more male employees. • business employees: male and female employees. • business wemployee: one or more female employees.
Designers Area
• designer: one or more male designers. • designers: male and female designers. • wdesigner: one or more female designers.
Education Area
• education director: one or more male directors. • education directors: male and female directors. • education wdirectors: one or more female directors. • education employee: one or more male employees. Includes teachers and educators in a non-university level (high schools, online courses, etc.) • education employees: male and female employees. • education wemployee: one or more female employees.
Education Mixed Area
• When an education related speaker was mixed with any other speaker type, the video was classified into this area.

Government Area

- government director: one or more male directors of government agencies.
- government directors: male and female directors.
- government wdirector: one or more female directors.
- government employee: one or more male employees.
- government employees: male and female employees.
- government wemployee: one or more female employees.
- politician: one or more male politicians.
- politicians: male and female politicians.
- wpolitician: one or more female politicians.

Media Area

- journalist: one or more male journalists.
- journalists: male and female journalists.
- wjournalist: one or more female journalists.

None Area

- When the video did not show any human (real or animated), it was classified as “none”.

Others Mixed Area

- stakeholders: if the uploaders specify they are a group of male and female citizens, scientists, business people and/or government related people acting together, then they are considered stakeholders.
- stakeholder: one or more male stakeholders.
- wstakeholder: one or more female stakeholders.
- when the video featured a combination of speakers from two or more areas unrelated to education, it also was classified on this area.

People Area

- celebrity: one or more male famous persons. Example: Leonardo DiCaprio.
- celebrities: male and female famous persons.
- wcelebrity: one or more female famous persons.
- citizen: one or more male persons.
- citizens: male and female persons.
- wcitizen: one or more female persons.

Professors Area

- professor: one or more male university professors.
- professors: male and female university professors.
- wprofessor: one or more female university professors.

Research Area
• researcher: one or more male researchers. • researchers: group of male and female researchers outside the jurisdiction of an institution. • wresearcher: one or more female researchers. • research director: one or more male director of a research institution. • research directors: male and female directors. • research wdirector: one or more female directors.
Students Area
• student: one or more male students. • students: male and female students. • wstudent: one or more female students.

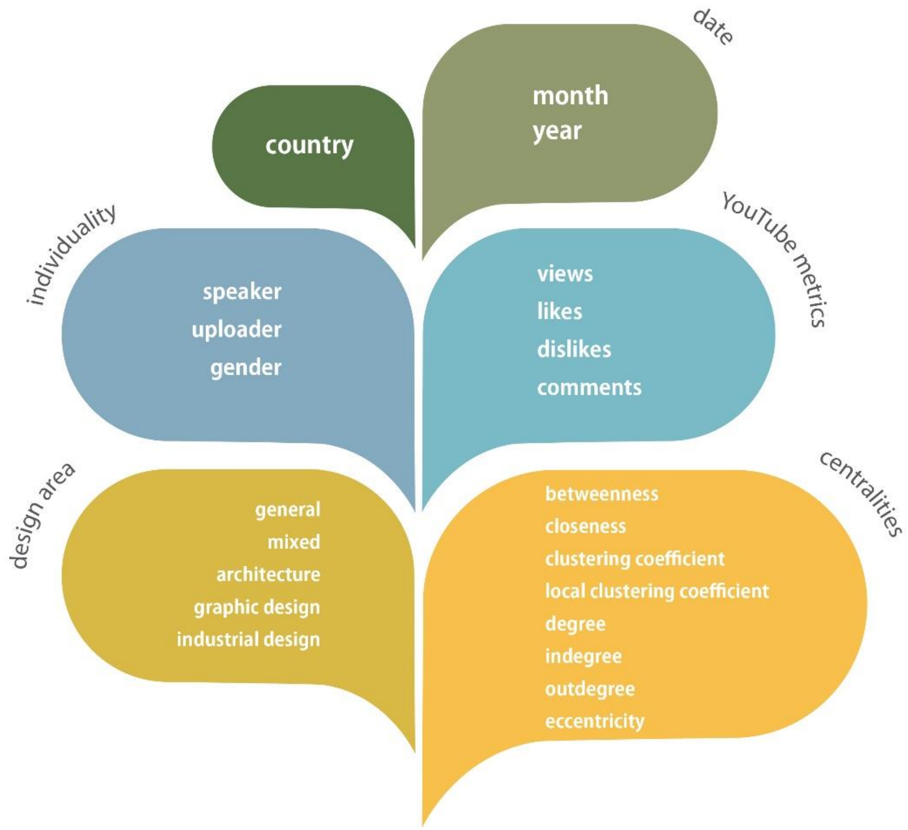
There was a hierarchy for speakers as well: professor > student > designer > researcher > director > employee > stakeholder > celebrity > citizen. It can be noted that the classification of speaker sometimes does not clarify if a person who is education related belongs to a university or not. That is why the videos were also classified as university related or not, according to the following cases:

- The video was shot at a university or the filmed event was hosted by a university.
- The video or its content were sponsored or endorsed by a university. Sponsored videos usually displayed the university's logo and/or name at the beginning or at the end.
- The YouTube channel belongs to a university or is sponsored by a university.
- At least one uploader and/or speaker is related to a university.

10.5 Selection Of Variables

Figure 6 describes the variables considered for statistical analysis in the first study, besides whether the videos were university related or not. Uploading date was divided into year and month. In order to explore the videos popularity, special attention was given to YouTube metrics (number of views, likes, dislikes and comments made on a video). Overall, country, date, individuality, YouTube metrics and design related variables were obtained from data extraction and watching/revision of the videos. Centralities were calculated with Gephi.

Figure 6. Video Variables



10.6 Statistical Analysis

Basic statistical analyses were conducted with SPSS (IBM Corp., 2013). Spearman correlation examined YouTube metrics, which are skewed and do not satisfy parametric assumptions. To test the difference between university related and unrelated videos, Mann-Whitney analysis was conducted for YouTube metrics, individuality variables and country variables.

Centrality variables tend to show collinearity in standard statistical tests (such as ANOVA), meaning that they had to be analysed with different methods. Therefore, network centralities and their relationships to other video data were examined with the Ucinet software (Borgatti et al., 2002). For some tests, data was converted from two-mode matrices to one mode matrices (relational data). Figure 7 provides an example. If two videos content was about graphic design, it is considered that these videos have a relationship, expressed as 1 in the matrix. If the pair of videos does not have a relationship, the absence of such relationship is expressed as 0 in the matrix.

Figure 7. Example of Conversion from Two Mode to One Mode Matrix

Video ID	Design Area	Design Area (Numerical Data)
a	graphic design	2
b	architecture	1
c	graphic design	2

	a	b	c
a	1	0	1
b	0	1	0
c	1	0	1

Several of the analyses involving relational data employ permutation, which is useful for non-parametric tests. The distribution of the test statistic under the null hypothesis is obtained through the calculation of all possible values of the test statistic under rearrangements of the data points labels (video IDs in this case). If the labels are exchangeable under the null hypothesis, results are significant.

Node level T-test uses a categorical variable to find differences between groups and can be defined as a T-test with data permutations. It has been employed before on social networks research (e.g. De Choudhury et al., 2013). Thus, Node level T-test was carried out with two mode matrices (university related and centralities) to find differences in connectivity, which might be indirectly related to popularity.

Quadratic Assignment Procedure (QAP) is an analysis used for categorical, ordinal and interval data expressed in one mode matrices (e.g. Borgatti & Cross, 2003; Vargas Meza et al., 2018). QAP is a combination of correlation and permutation test for the independence of matrices. It was conducted with centrality variables chosen based on the significant differences found with Node Level T-tests, country variables, date variables, individuality variables, one YouTube metrics variable, and design related variables. The objective was to find which variables were related to the videos' popularity.

Each data set will be mentioned from this point onwards with a set of capital letters "SD" plus the two first letters of the name of the language. Therefore, the English data set will be referred as SDEN, and the Spanish data set as SDES.

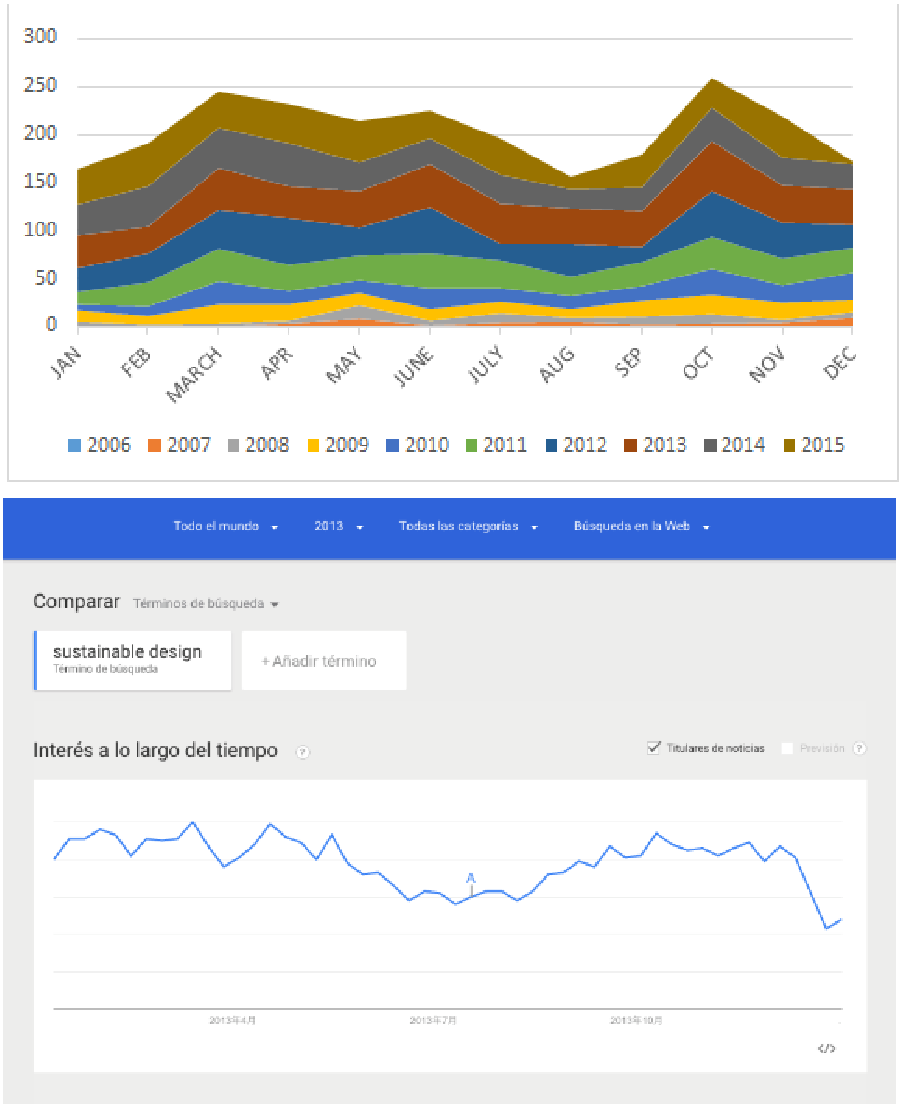
11 RESULTS

11.1 SDEN Videos

11.1.1 Classification of SDEN videos

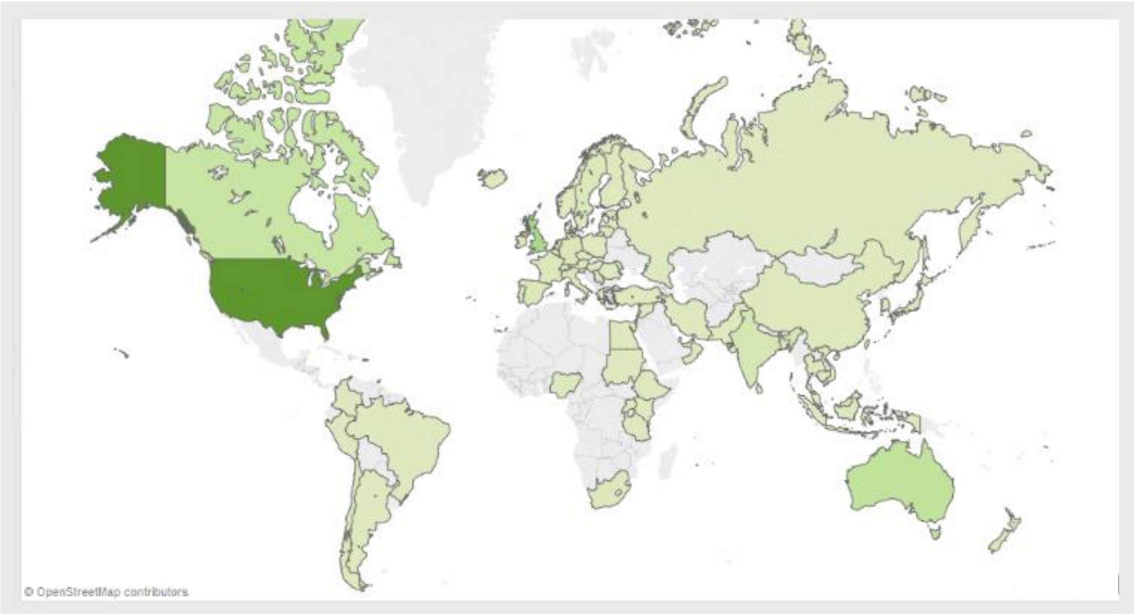
SDEN videos were uploaded between the years 2006 and 2015. Figure 8 shows the distribution of uploading dates, compared with Google's searches on sustainable design in a typical year. Both uploading dates and search volume coincide. Moreover, the quantity of videos has been increasing over time, particularly since 2011.

Figure 8. SDEN Video Uploads and Search Volume (Google Trends, 2015)



From 2,452 videos related to the keywords, 1,819 videos disclosed location on 75 countries, shown shaded on Figure 9. The more intense the color, the bigger the number of videos belonging to the country. As the keywords were in English, the dataset contained videos mostly from the U.S. (862), unclear locations (632), and UK (241). For a complete list of number of videos per country, Annex 1 can be consulted.

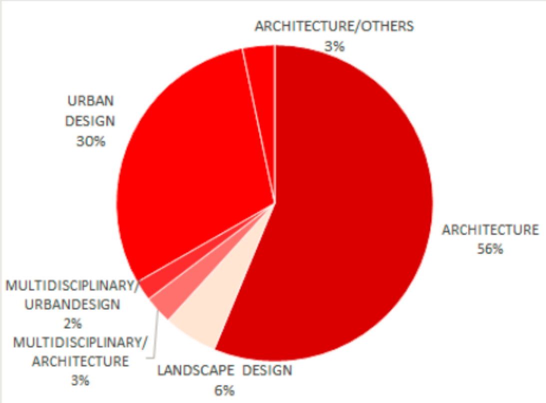
Figure 9. Countries of SDEN Videos



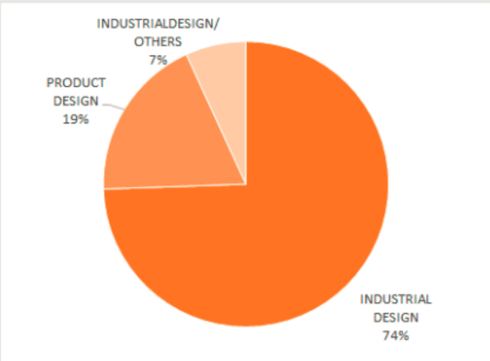
Regarding design discussed and/or shown in the videos, numbers and percentages of videos per area are shown in Figure 10. 1,310 videos (53%) were related to architecture, 321 to industrial design (13%), 95 to graphic design (4%), 355 to the mixed area (15%), and 371 to the general area (15%). As some of the design types were found in small numbers (e.g. 5 animation videos), they were aggregated in the percentages called *Others* to simplify the figures. The great quantity of videos related to architecture and industrial design might be due to the standardization of some methods and rules (e.g. LEEDS certification and life cycle assessment) in such disciplines.

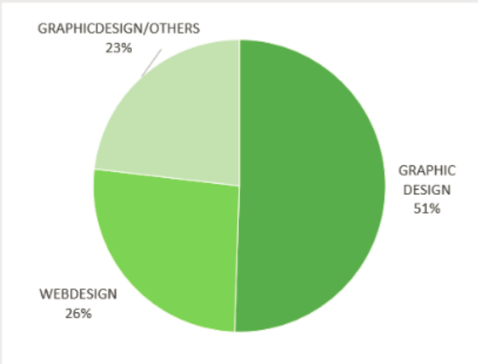
Figure 10. Percentage of Design Types in SDEN

ARCHITECTURE AREA	**1310**
ARCHITECTURE	737
LANDSCAPE DESIGN	72
MULTIDISCIPLINARY/ARCHITECTURE	38
MULTIDISCIPLINARY/URBAN DESIGN	27
URBAN DESIGN	393
ARCHITECTURE/OTHERS	43

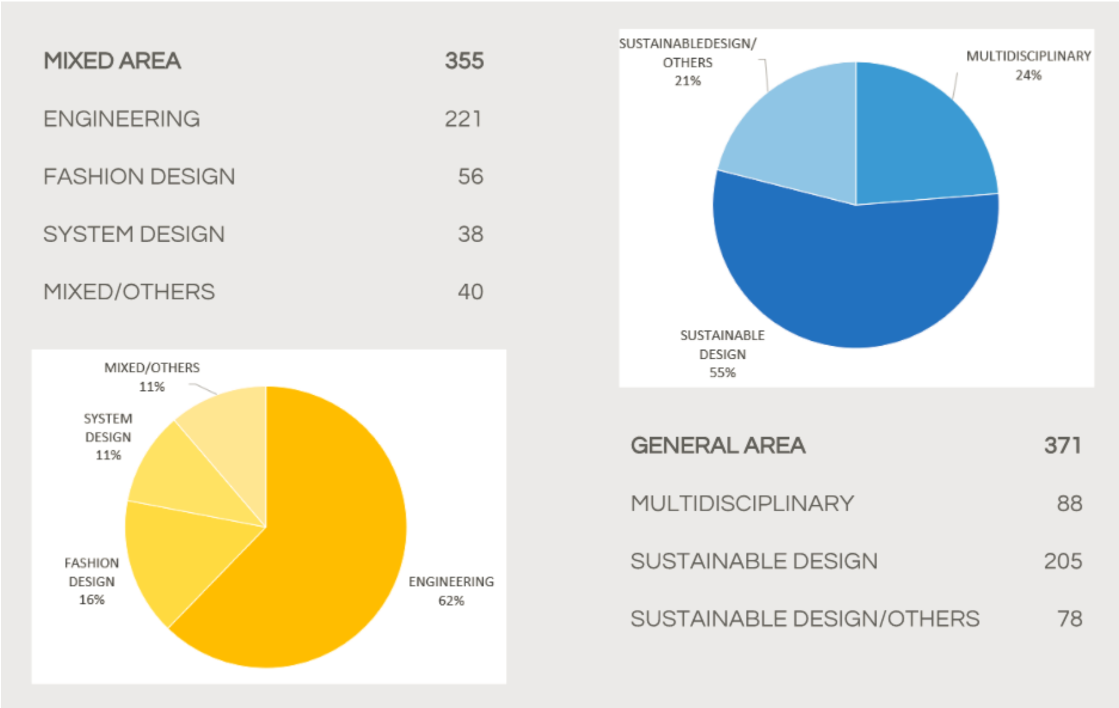


INDUSTRIAL DESIGN AREA	**321**
INDUSTRIAL DESIGN	239
PRODUCT DESIGN	60
INDUSTRIAL DESIGN/OTHERS	22



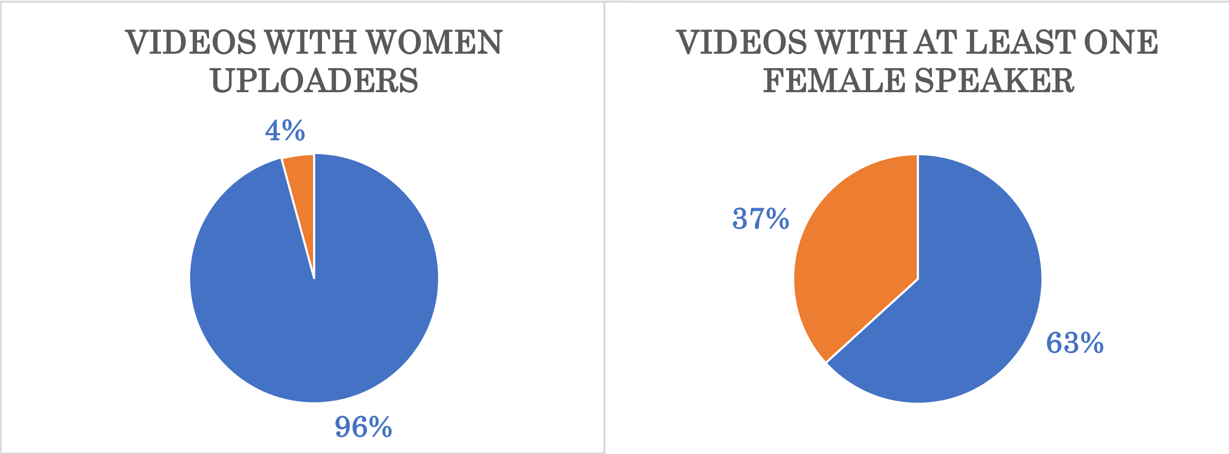


GRAPHIC DESIGN AREA	**95**
GRAPHIC DESIGN	48
WEB DESIGN	25
GRAPHIC DESIGN/OTHERS	22



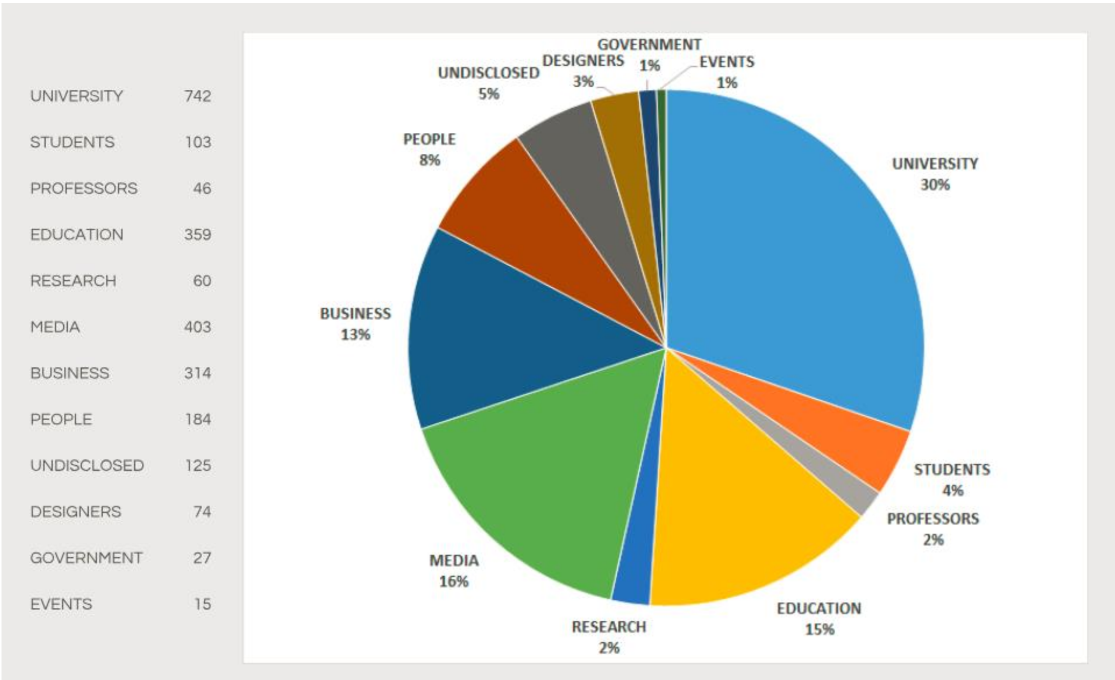
Concerning gender, although its ratio on the video datasets is difficult to determine in case of uploaders (as institutions do not have gender), the classification of videos shed the results in Figure 11. Blue represents videos without female presence, while orange represents female presence. With 37% of videos featuring at least one woman speaker and 4% of uploaders disclosed as female, women presence in the videos is still modest. Moreover, the distribution of female speakers per design area shows that they are mostly present in Architecture (51%) and General areas (17%), suggesting that women are particularly involved in theory and integral aspects of sustainable design.

Figure 11. Presence of Female Uploaders and Speakers in SDEN



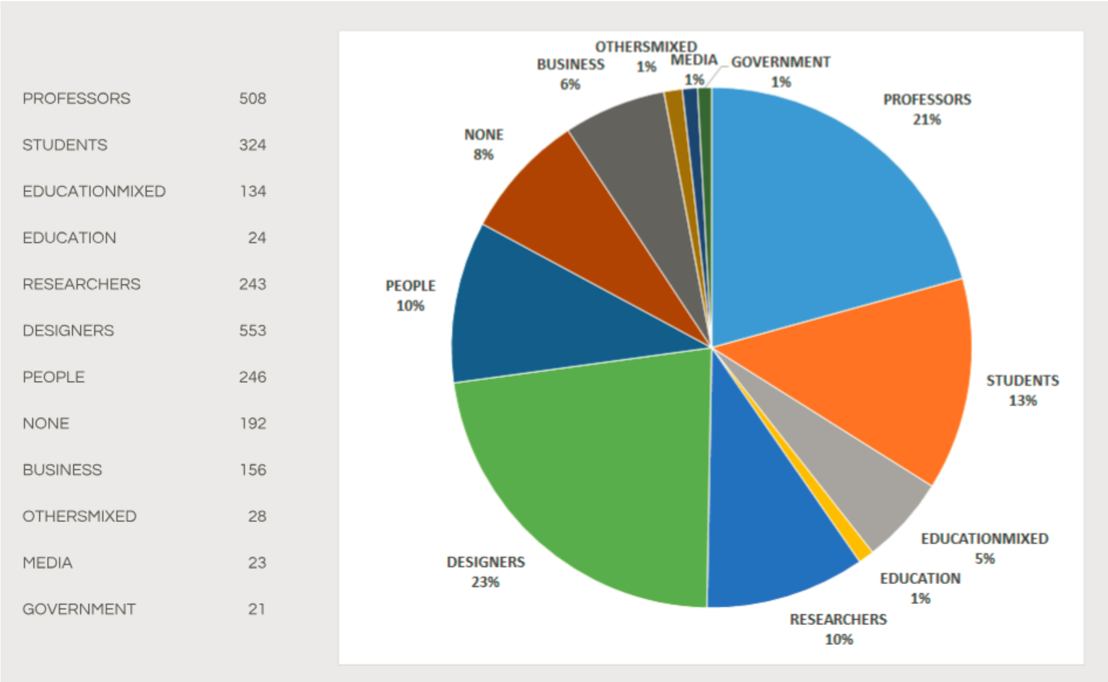
Top video uploaders were universities (30%), media channels (16%), education related channels (15%) and business channels (13%), as shown in Figure 12. Numbers in the left represent total of videos classified according to uploader, which are consistent with the 1,378 (56.19%) videos found to be university related.

Figure 12. Uploaders of SDEN



As for top speakers, Figure 13 shows that 23% were identified as designers, 21% as professors and 13% as students. Once more, the number in the left represents the total number of videos classified according to speaker. It should be noted that only 8% of the videos did not feature a speaker, showing a product or service instead. This suggests a strong human component in the communication of sustainable design.

Figure 13. Speakers in SDEN



11.1.2 YouTube Metrics in SDEN

Table 9 shows the YouTube Metrics for SDEN. There was some missing data in the case of number of likes, dislikes and comments, as some videos have such features disabled or private. It can be noted that the average of likes is 26.77 times bigger than the number of dislikes, while average number of views is 1,272.85 times bigger than number of comments.

Table 9. Descriptive Statistics for YouTube Metrics in SDEN

Metric	Mean	Std. Deviation	N
Number of views	11593.144	137397.2513	2452
Number of likes	54.761	441.9473	2388
Number of dislikes	2.045	16.7847	2388
Number of comments	9.108	85.3992	2444

A descriptive analysis was performed on 10 SDEN top videos in terms of YouTube metrics. Tables with detailed information on such videos can be consulted in Annexes 2 to 5. Most viewed videos mainly showed industrial design and architecture prototypes uploaded by business and media channels, located in WEIRD countries (notably the U.S.). Four videos didn't have a speaker. *The story of stuff*, an educative channel, is among the top three with more views and was the only one among these ten videos with a women speaker. Only two videos were university related.

As for the most viewed videos related to universities, they were mostly about industrial design and architecture projects from the U.S. and UK. Three videos were about theoretical lectures and three were uploaded by universities. As for speakers, three videos were about professors, three about students and three counted with female presence. The interaction on these top videos was lower than with university unrelated videos.

The most liked videos were generally about concrete examples of sustainable design uploaded by media channels from the U.S. Only two videos were university related. Two were from the TED channel and once more, *The story of stuff* were among the top three videos, followed by *3onlinedocumentaries*. The ten most liked videos related to universities were mostly about concrete architecture projects, uploaded by media channels in WEIRD countries. Speakers were mostly professors and two videos counted with female presence. Moreover, two videos were from the TEDx Talks channel and another was from the TED channel.

Most disliked videos were often about theory and projects on architecture and industrial design, uploaded by media channels from the US. Most of the speakers were categorized as people. The TED channel appeared twice and only one video was related to universities. The ten most disliked videos related to universities were projects on architecture and industrial design, uploaded by media channels from the U.S. Most speakers were professors, four videos counted with female presence and two videos were uploaded by universities.

The ten most commented videos were a mix of theory and methods, showing complex examples on architecture. Most videos were uploaded by media channels from the U.S. and most speakers were categorized as people. The TED channel appeared three times and noted education related channels were *3onlinedocumentaries* and *The story of stuff*. There were no university related videos among these videos. Most commented videos related to universities are about pilot projects on architecture and industrial design, uploaded by media channels from the western developed world (notably the U.S.). Speakers were mostly professors and two videos counted with female presence. TED and TEDx Talks were notable channels again, and the number of comments was around half compared with the ten most commented videos.

Spearman correlation was conducted between YouTube interaction metrics (details are in Annex 6). Number of views was correlated ($p \leq .01$) with number of likes (0.83), number of dislikes (0.56) and number of comments (0.61). Views are counted in YouTube when the user initiated intended play of a video, not in case of "auto play, scripted play, spam play, or playback" (Hook, 2017). Moreover, there was missing data in the other interaction metrics. Therefore, given that number of views was the most stable measure, it was selected as proxy for popularity when conducting most of the other analyses.

11.1.3 Mann-Whitney U Test in SDEN

Table 10 shows some significant differences ($p<0.05$) between the university unrelated group ($N=1051$) and related group ($N=1401$). Number of views ($Mdn1=1263.32$, $Mdn2=1198.88$, $U=697525.50$), dislikes ($Mdn1=1231.13$, $Mdn2=1167.28$, $U=693925.50$) and comments ($Mdn1=1264.83$, $Mdn2=1190.77$, $U=687009.50$) had higher ranks in the group unrelated to university; while likes did not show significant differences. This can be interpreted as more popularity in the case of videos unrelated to universities.

Table 10. Summary of Mann-Whitney U Test in SDEN.

Complete Test Results can be Consulted on Annex 7.

University Related?		N	Mean Rank	Sum of Ranks
Number of Views	No	1051	1263.32	1327751.50
	Yes	1401	1198.88	1679626.50
	Total	2452		
Number of Dislikes	No	1018	1231.13	1253291.00
	Yes	1370	1167.28	1599175.00
	Total	2388		
Number of Comments	No	1047	1264.83	1324277.50
	Yes	1397	1190.77	1663512.50
	Total	2444		

Design area Architecture	No	1051	1278.40	1343602.50
	Yes	1401	1187.56	1663775.50
	Total	2452		
Design area Industrial design	No	1051	1187.32	1247870.00
	Yes	1401	1255.89	1759508.00
	Total	2452		
Country Australia	No	1051	1206.99	1268550.50
	Yes	1401	1241.13	1738827.50
	Total	2452		
Country UK	No	1051	1185.32	1245774.00
	Yes	1401	1257.39	1761604.00
	Total	2452		
Country US	No	1051	1117.46	1174446.50
	Yes	1401	1308.30	1832931.50
	Total	2452		

Architecture videos from the group unrelated to universities had a significantly higher rank (*Mdn1=1278.40, Mdn2=1187.56, U=681674.50*), while Industrial Design videos related to universities had a significantly higher rank (*Mdn1=1187.32, Mdn2=1255.89, U=695044*). This might reflect a divergence of focus between universities and other interest groups (media, education, businesses, citizens, etc.). The general Sustainable Design area and the Mixed area did not show significant differences among the two groups, which point to convergence on these areas.

Regarding countries, Australia (*Mdn1=1206.99, Mdn2=1241.13, U=715724.50*), UK (*Mdn1=1185.32, Mdn2=1257.39, U=692948*), and the U.S. (*Mdn1=1117.46, Mdn2=1308.30, U=621620.50*) showed a significantly higher rank on videos related to university, while other countries with many videos (Canada with 99, India with 44 and Netherlands with 49) did not show significant differences among the two groups. This suggests that, regarding diffusion of sustainable design in YouTube, universities located in Australia, UK and the U.S. were more active than other interest groups, while Canada, India and Netherlands had more diverse stakeholders involved.

11.1.4 Network Centralities in SDEN

Table 11 shows the network analysis results in SDEN data. The low density suggests that this is a disconnected graph, but the high number of connected components, the number of shortest paths and betweenness imply that several videos are holding the graph together.

Table 11. Network Centralities in SDEN

Centrality Name	Value
Number of nodes	2452
Number of ties	5422
Connected Components	956
Density	0.001
Diameter	20
Modularity	0.756
Average Path Length	6.754
Number of shortest paths	800168
Betweenness	1877.731
Closeness	3.317
Clustering Coefficient	0.132
Degree	2.211

Degree centrality reflects how many connections a video has, but not the direction of such connections. Therefore, a descriptive analysis was performed on SDEN top videos in terms of indegree and outdegree (details on such videos can be consulted in Annexes 8 and 9).

The 10 videos highest on indegree centrality were mostly about prototypes and integrated views of sustainable design mainly related to industrial design (including 4 about Shell Eco Marathon), uploaded mostly by WEIRD countries (Netherlands and the U.S.). There was female presence among uploaders in one video, while speakers were mainly students and designers, with four videos counting with female presence. Seven videos were university related. The 10 videos highest on indegree centrality related to universities were about industrial design prototypes (including 6 about Shell Eco Marathon), uploaded mostly by WEIRD countries and with female presence among the uploaders in one video. Speakers were mainly students and half of the videos counted with female presence.

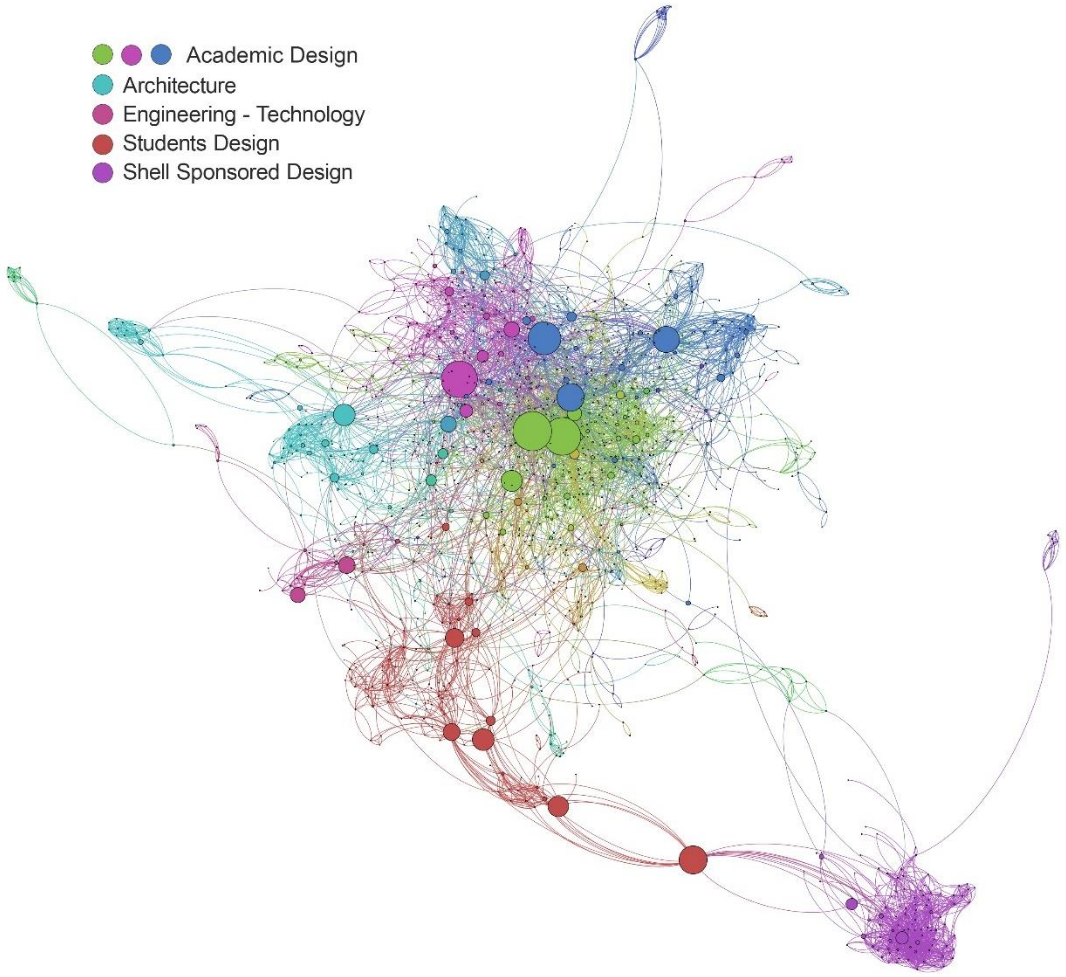
Top 10 videos in terms of indegree tended to have a high number of views, and their amount of dislikes also tended to be higher than the mean. The top 10 videos in terms of indegree related to universities tended to have a high number of dislikes as well. This suggests an association between how well linked the videos are and popularity, although this relationship tends to be negative.

As for the 9 videos highest on outdegree centrality, they were mostly about industrial design prototypes (including 5 about the Shell Eco Marathon), uploaded mainly by businesses and universities in developed countries (notably the U.S.). There was female presence among the uploaders in one video, while speakers were mostly students and five videos counted with female presence. 8 videos were university related.

The 8 videos highest on outdegree centrality related to universities were mainly about industrial design prototypes (including 5 about the Shell Eco Marathon), uploaded mostly by developed countries (notably the U.S.). There was female presence among the uploaders of one video, while speakers were mostly students and four videos counted with female presence. In sum, the Shell company was highly connected in the SDEN network, probably being sponsored to appear frequently among recommended videos.

Betweenness centrality was particularly high on this network, which implies that several videos were acting as bridges between video groups. Figure 14 shows the SDEN network without unlinked videos. Nodes size reflects betweenness centrality from a value of 161,025.898 to 0. The nodes are arranged through the Force Atlas algorithm (Jacomy et al., 2014), which is useful to explore groups within a network; and colored with the Markov Cluster algorithm, which is based on simulation of stochastic flow and is also employed to detect groups in a network (see van Dongen, 2000). Three highly interlinked clusters colored in green, purple and blue and located in the upper right side of the figure conform a group of university and professors-based design (hence the name of the group, *Academic Design*). Students design related videos (colored in red) connect a group of Shell related videos (colored in dark purple) with the academic group, particularly a video about students from Singapore (shown as the biggest node in the inferior part of Figure 12).

Figure 14. SDEN Graph Reflecting Betweenness Centrality (161025.898 to 0)

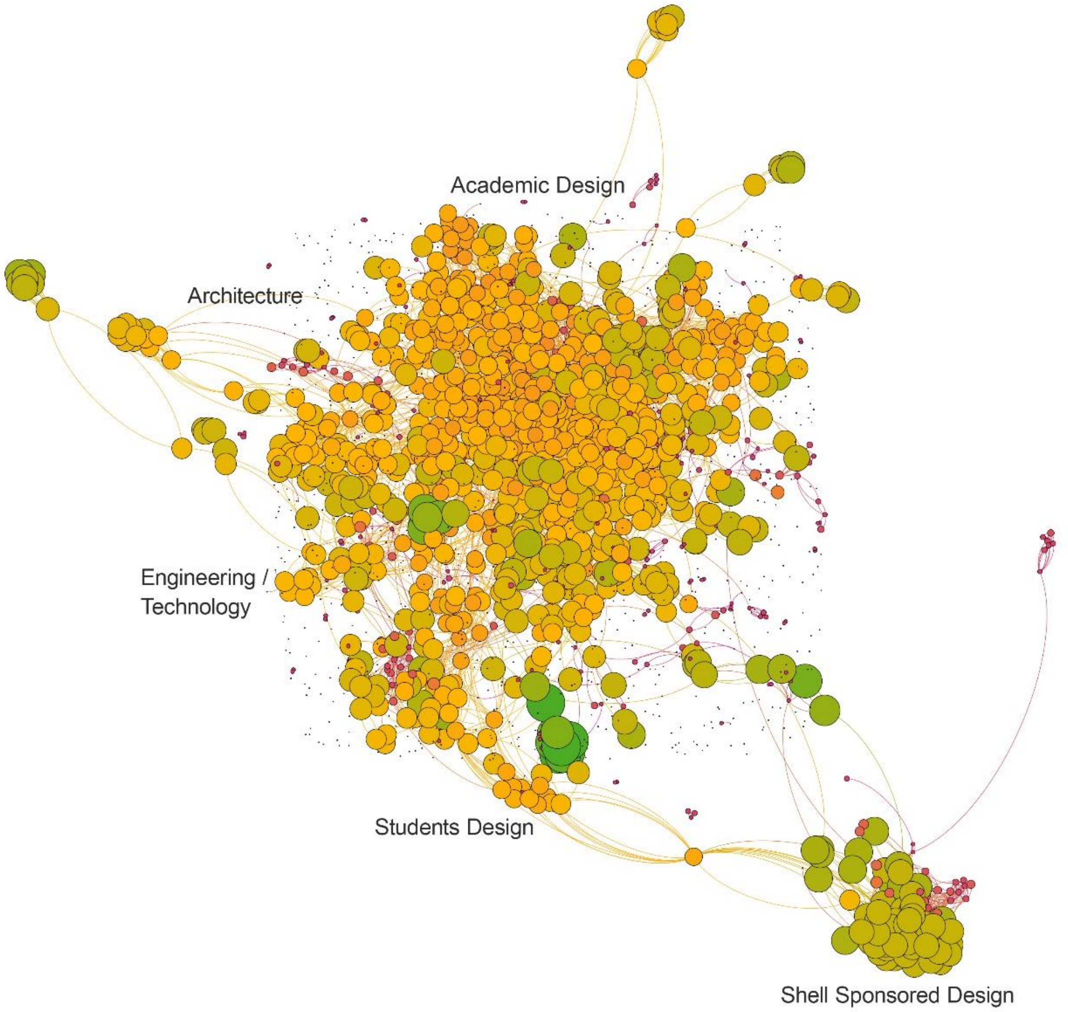


A descriptive analysis was performed on SDEN top videos in terms of betweenness as well (details can be consulted in Annex 10). The 10 videos highest on betweenness centrality were mostly about prototypes, real products and integrated views about sustainable design on the architecture area, uploaded mainly by universities and educational channels in WEIRD countries (notably the U.S.). Four speakers were designers, 5 videos counted with female presence and 6 channels were university related.

The ten videos highest on betweenness centrality related to universities were mostly about prototypes and integrated views about sustainability on the architecture area. Videos were uploaded mainly by universities in WEIRD countries, and one video had female presence among the uploaders. Most speakers were professors and designers, and three videos counted with female presence.

It was also noted that closeness centrality was higher than degree. Given that a high closeness implies an easier access to other videos, a graph was drawn through the Force Atlas algorithm, as shown in Figure 15. Node size represents closeness from a value of 13.01 to 0. Hence, the bigger the node, the higher its closeness. Shell related videos have high closeness, but the biggest nodes belong to videos about students from Australia, located in the students' design cluster. Also, big nodes connecting the academic design clusters with Engineering-Technology belong to an American school that offers certification on sustainable design.

Figure 15. SDEN Graph Reflecting Closeness Centrality (13.01 to 0)



A descriptive analysis on top videos in terms of closeness was performed (details can be consulted in Annex 11). The 11 videos highest on closeness centrality were mostly about theory on engineering and integral views in architecture. 8 were uploaded by universities located in Australia and UK, and ten were related to universities. Speakers were professors on five videos and there was female presence in three. In sum, there is a combination of university and non-university videos with high video access in the network.

11.1.5 Node Level T-test in SDEN

Table 12 shows differences between the university related group and unrelated group at node level. Only degree, outdegree and closeness centralities were significantly different (p<0.05), being outdegree the centrality with the highest significance (p<0.0005). It was noted that university related videos had higher metrics than unrelated videos. Therefore, indegree, outdegree and closeness were chosen to conduct further analyses.

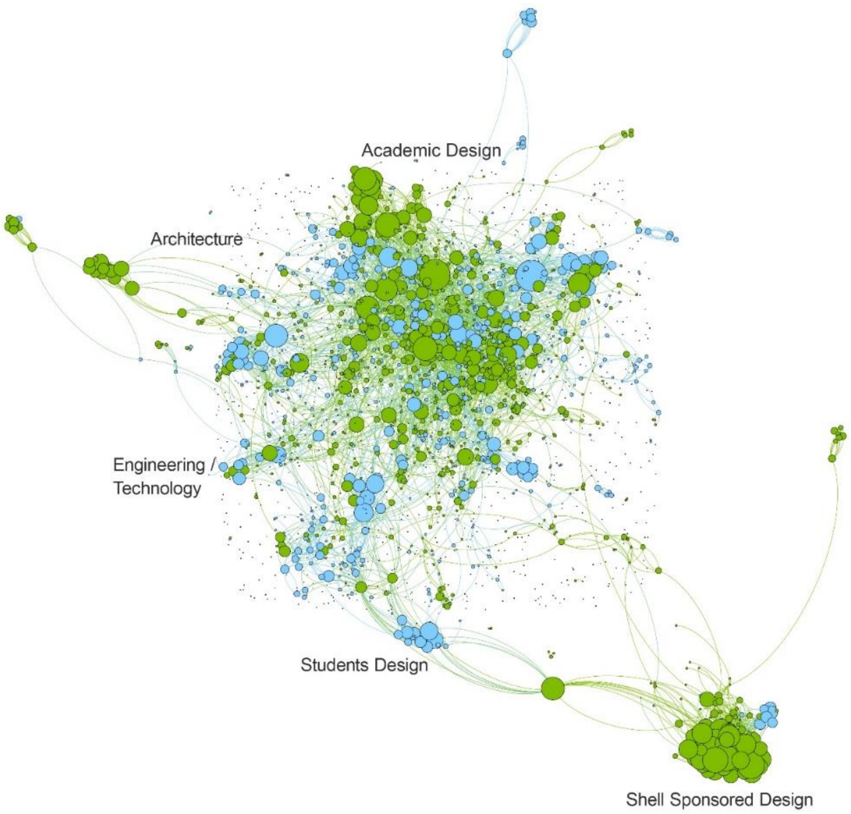
Table 12. Node Level T-test in SDEN. Significant differences are marked with asterisks

	Degree			Out Degree	
	Unrelated to University	Related to University		Unrelated to University	Related to University
Mean	3.942	4.783	Mean	1.928	2.242
Std. Dev.	7.59	9.198	Std. Dev.	2.746	3.642
Means Dif.	-0.841		Means Dif.	-0.496	
T-Test	0.0162*		T-Test	0.0003*	
	Closeness			Betweenness	
	Unrelated to University	Related to University		Unrelated to University	Related to University
Mean	3.158	3.437	Mean	1640.667	2055.571
Std. Dev.	3.193	3.429	Std. Dev.	8479.182	10397.6
Means Dif.	-0.279		Means Dif.	-414.905	
T-Test	0.0407*		T-Test	0.3013	
	Clustering Coefficient			Local Clustering Coefficient	
	Unrelated to University	Related to University		Unrelated to University	Related to University
Mean	0.125	0.137	Mean	0.049	0.054
Std. Dev.	0.227	0.241	Std. Dev.	0.097	0.104
Means Dif.	-0.012		Means Dif.	-0.005	
T-Test	0.1982		T-Test	0.1995	
	Eccentricity			In Degree	
	Unrelated to University	Related to University		Unrelated to University	Related to University
Mean	6.245	6.734	Mean	2.014	2.359

Std. Dev.	6.466	6.745	Std. Dev.	5.58	6.616
Means Dif.	-0.488		Means Dif.	-0.345	
T-Test	0.0713		T-Test	0.1772	
Independent variable: University Related. Number of objects: 1051, 1401. Number of permutations: 10 000. Random seeds. Results marked with (*) are significant.					

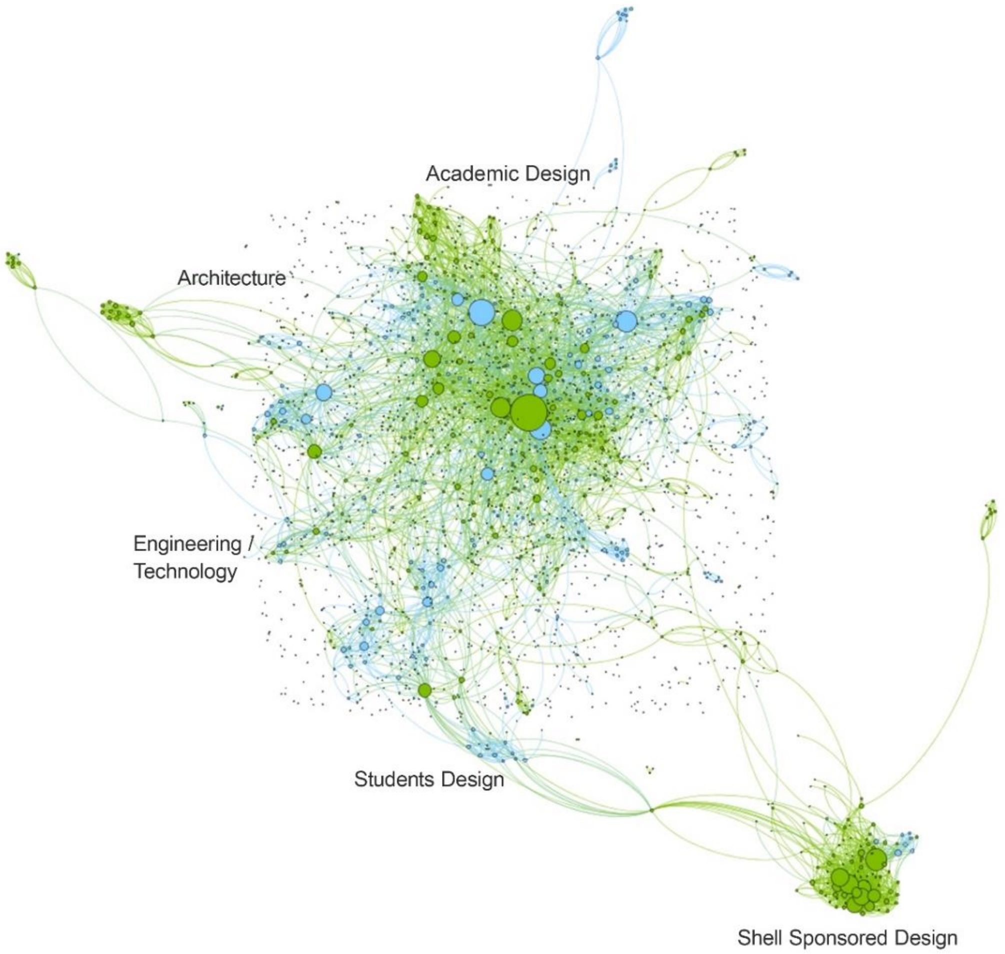
A graph exploring the relationship between university related and unrelated groups, and outdegree centrality was drawn through the Force Atlas algorithm. Figure 16 shows the university related videos in green, while the unrelated videos are colored in blue. Node size reflects outdegree from a value of 23 to 0. Three assumptions can be stated through the graph: 1) The academic design cluster has more videos unrelated to university than what could be inferred by grouping the videos through the Markov Cluster algorithm; 2) Videos related to students design marked in blue (meaning that they belong to institutions outside university, e.g. high schools) are more relevant in connecting the videos to the academic design cluster than those about university students; and 3) Shell related videos are among the best connected within their own group.

Figure 16. University Relationship and Out Degree (23 to 0)



In contrast, nodes in Figure 17 reflect in degree from 112 to 0. This centrality was not significantly different between the two groups. Coloring and clustering algorithm used in this figure are the same than in the previous one. Two main assumptions can be made: 1) The highest nodes in terms of in degree are university related; and 2) Once more, Shell related videos are among the best connected.

Figure 17. University Relationship and In Degree (112 to 0)



11.1.6 QAP Correlations in SDEN

QAP results are shown in Table 13, where correlations are shaded in green and slight correlations, in yellow. There were no strong correlations between categorical and ordinal variables, or between categorical variables and network centralities. The variable that was most relevant for the study (number of views, a proxy for video popularity) did not have strong correlations.

Table 13. QAP Correlations in SDEN

Variables		1	2	3	4	5	6	7	8	9	10	11	12
number of views	1	1	0	0.001	-0.001	0.004	0.001	0	0	0	0.003	0.002	0.008
uploader area	2	0	1	0.075	0.021	0.009	0.002	0.079	0.267	0.019	-0.009	-0.007	-0.016
speaker area	3	0.001	0.075	1	0.127	0.003	0	0.023	0.199	0.02	-0.007	-0.007	-0.015
speaker gender	4	-0.001	0.021	0.127	1	0	0.002	0.019	0.016	-0.007	-0.018	-0.013	-0.019
Year	5	0.004	0.009	0.003	0	1	0.004	-0.007	0.007	0.001	0.007	0.006	0.013
Month	6	0.001	0.002	0	0.002	0.004	1	0.002	0	0	0.001	0.001	0.001
Country	7	0	0.079	0.023	0.019	-0.007	0.002	1	0.051	0.021	-0.001	0	0.001
university related	8	0	0.267	0.199	0.016	0.007	0	0.051	1	-0.005	0	-0.002	-0.005
design area	9	0	0.019	0.02	-0.007	0.001	0	0.021	-0.005	1	-0.029	-0.016	-0.006
Closeness	10	0.003	-0.009	-0.007	-0.018	0.007	0.001	-0.001	0	-0.029	1	0.829	0.419
Outdegree	11	0.002	-0.007	-0.007	-0.013	0.006	0.001	0	-0.002	-0.016	0.829	1	0.371
Indegree	12	0.008	-0.016	-0.015	-0.019	0.013	0.001	0.001	-0.005	-0.006	0.419	0.371	1
N=2452, P≤0.005													

5.1.1 Outlink Analysis in SDEN

The small correlations coincide with results by Feroz-Khan and Vong (2014), who also found that inlinks, outlinks, offline fan base and fame play crucial roles in interaction with top viral YouTube videos. Thus, analysis of links outside YouTube for top 95 videos in terms of number of views was conducted using webometric analyst software (Thelwall, 2012). Table 14 shows the 14 most frequent domains (webpages) in which SDEN videos were shared. Facebook and other social networks were frequently used, followed by a few academic sites like slideshare, scribd and coursehero that function as document repositories.

Table 14. Outlink Analysis of 95 Top SDEN Videos

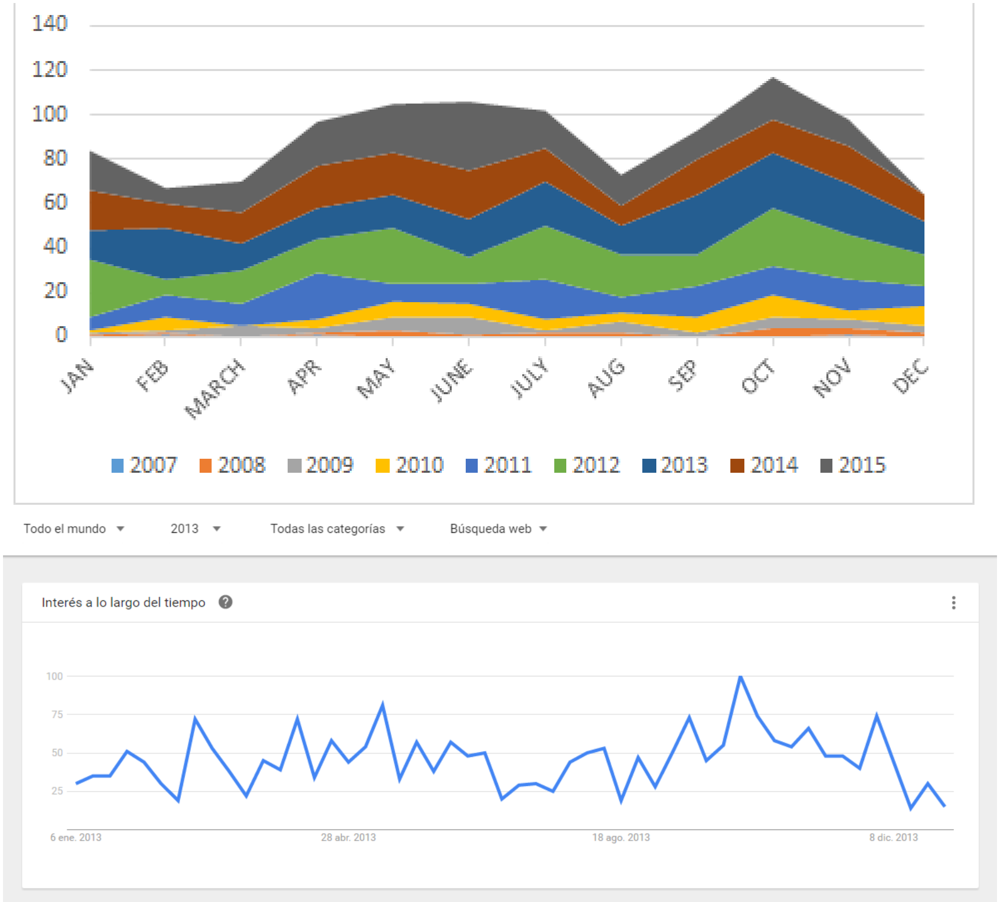
Domain	Number of Video Shares
www.facebook.com	70
es-la.facebook.com	33
www.slideshare.net	23
www.reddit.com	20
www.scribd.com	20
twitter.com	18
www.coursehero.com	17
sites.google.com	14
www.taringa.net	12
issuu.com	12
www.linkedin.com	12
www.academia.edu	11
documents.mx	10
www.vidinfo.org	10

11.2. SDES Videos

11.2.1 Classification of SDES Videos

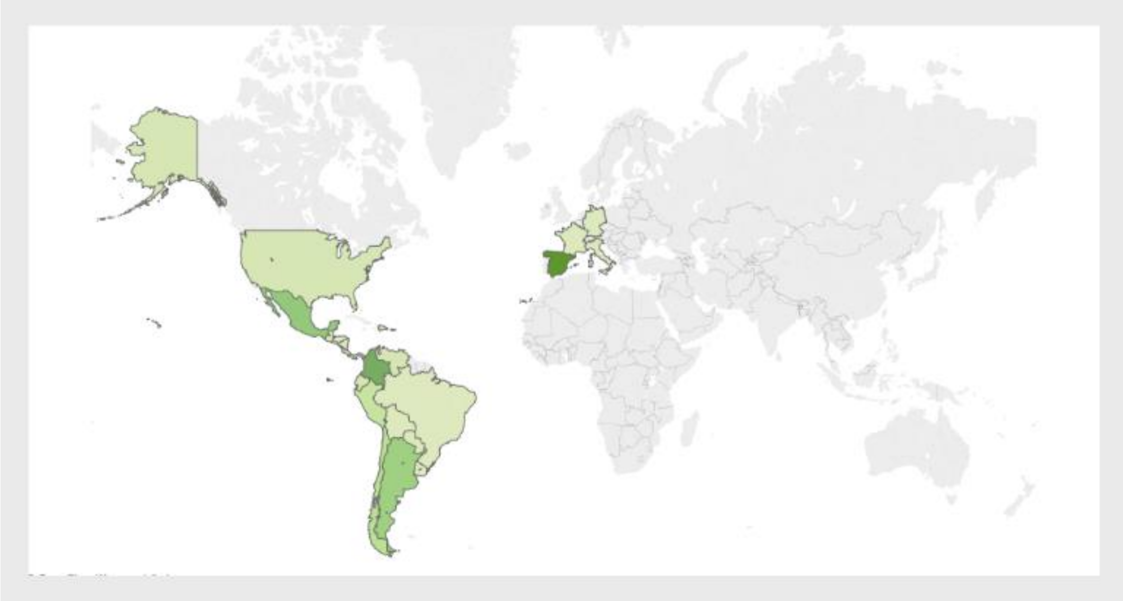
SDES videos were uploaded between 2007 and 2015. Figure 18 shows the distribution of uploading dates, compared with Google's searches on *Diseño Sostenible* (Sustainable Design) in a typical year. Uploading dates and search volume coincide once more and the quantity of videos has been increasing across time, also since 2011.

Figure 18. SDES Video Uploads and Search Volume (Google Trends, 2015)



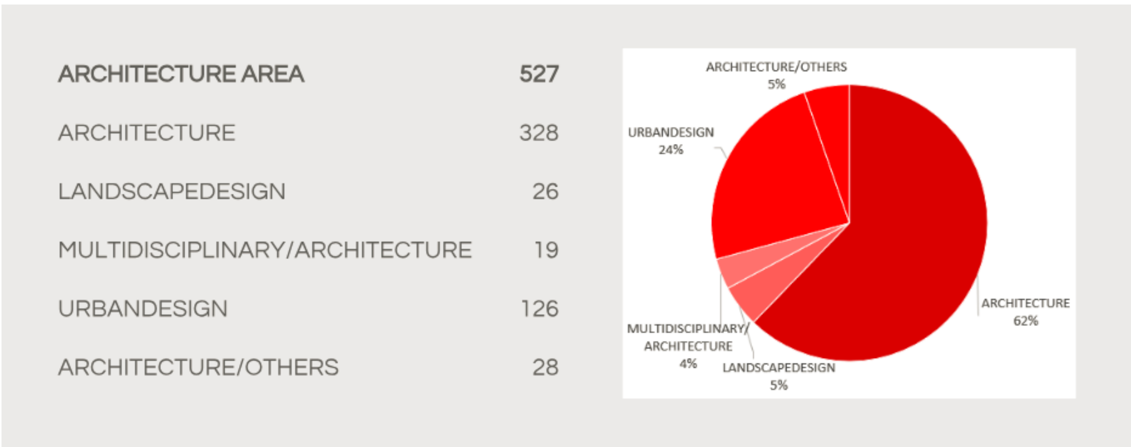
From 1,076 videos related to the keywords, 789 videos disclosed location in 23 countries, shown shaded on Figure 19 (the more intense the color, the bigger the number of videos belonging to the country). This dataset contained videos mostly from unclear locations (287), Spain (239) and Colombia (180). Some videos were located in European countries where Spanish is not the official language. For a complete list of number of videos per country, Annex 1 can be consulted.

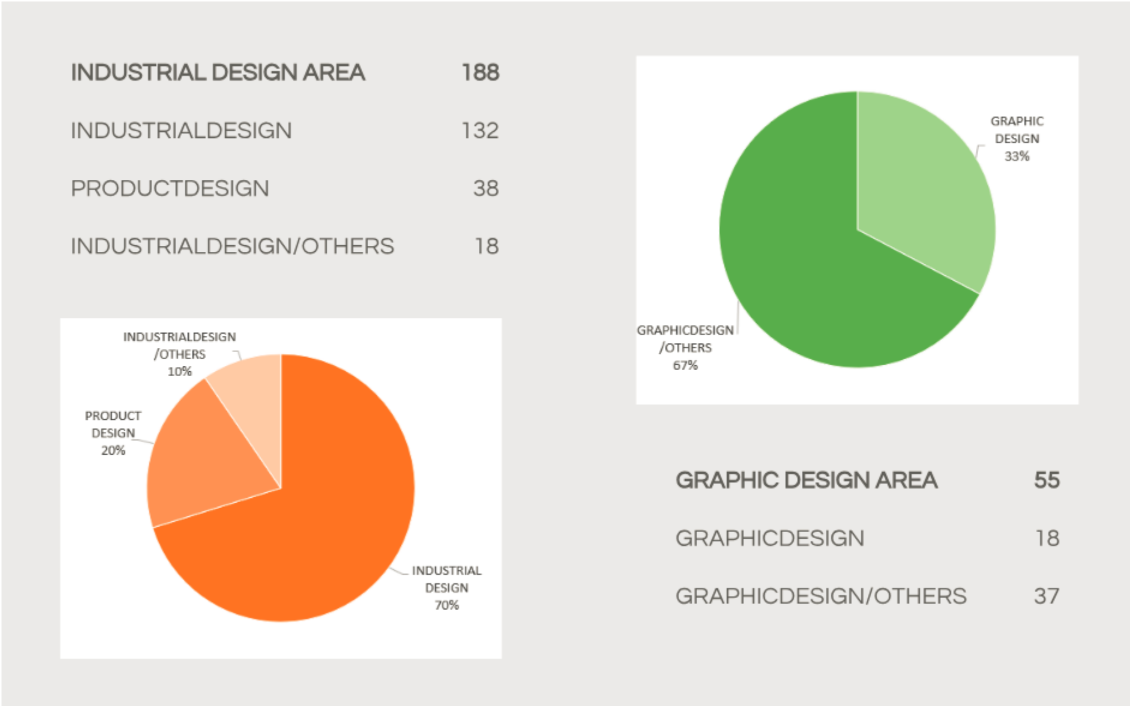
Figure 19. Countries of SDES Videos

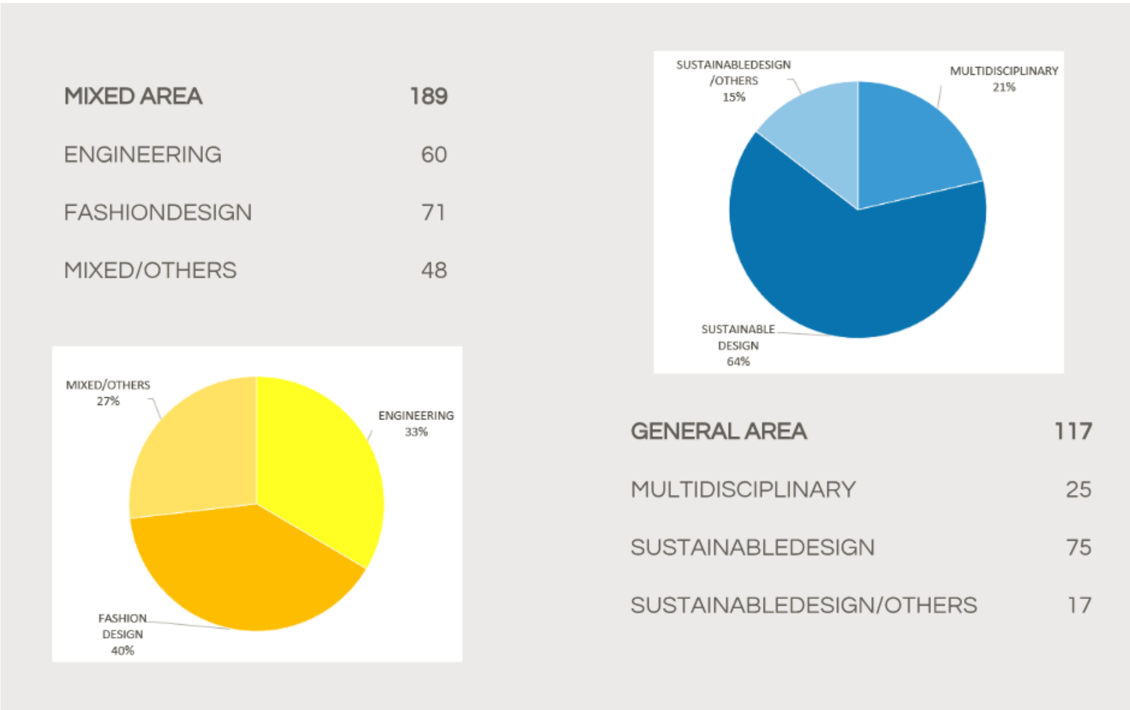


Regarding design, percentages of videos per area are shown in Figure 20. 527 videos (49%) were related to architecture, 188 to industrial design (17%), 55 to graphic design (5%), 189 to the mixed area (18%), and 117 to the general area (11%). The number in the right represents the quantity of videos of a given design type. These numbers suggest that the standardization of methods and rules in architecture and industrial design have contributed to the diffusion of sustainable design among Spanish speakers, in similarity to SDEN videos. The prominence of fashion design related videos in the mixed area should also be noted.

Figure 20. Percentage of Design Types in SDES

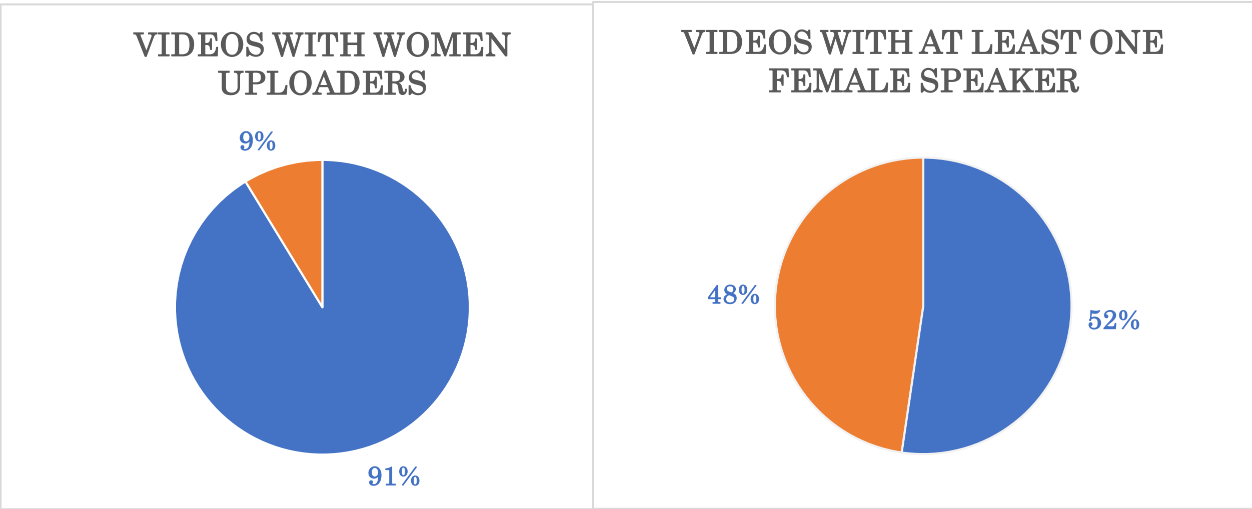






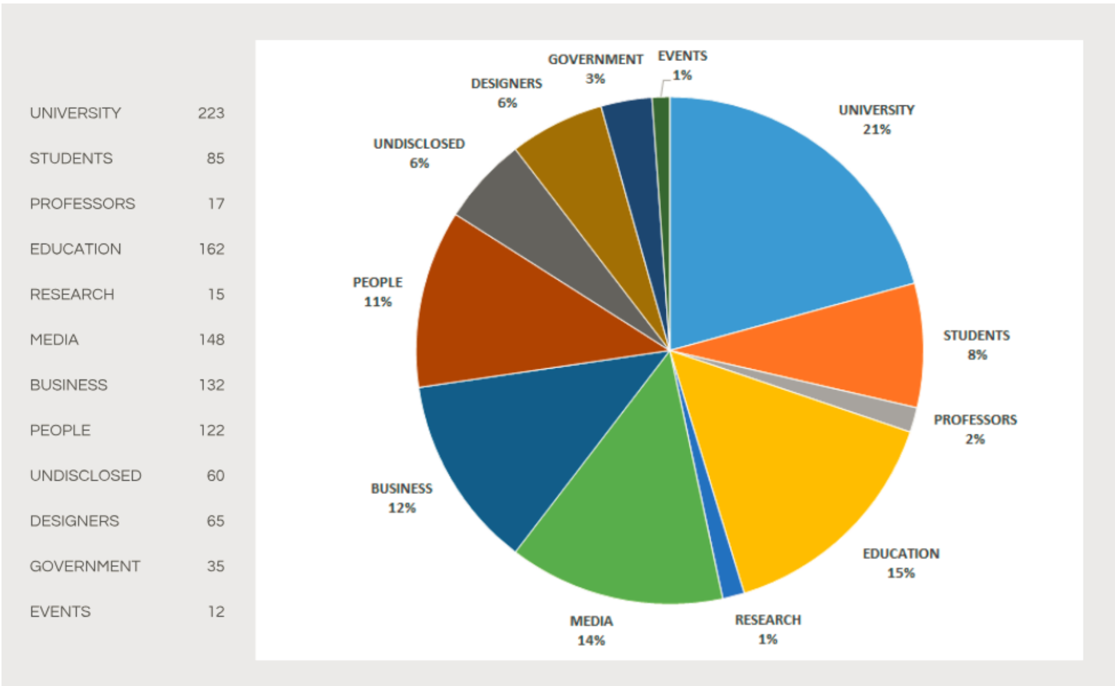
Classification of videos according to gender shed the results in Figure 21. Blue represents videos without female presence, while orange represents female presence. Female presence in SDES was higher than in SDEN, with 48% of videos featuring at least one woman speaker and 9% of uploaders disclosed as female.

Figure 21. Presence of Female Uploaders and Speakers in SDES



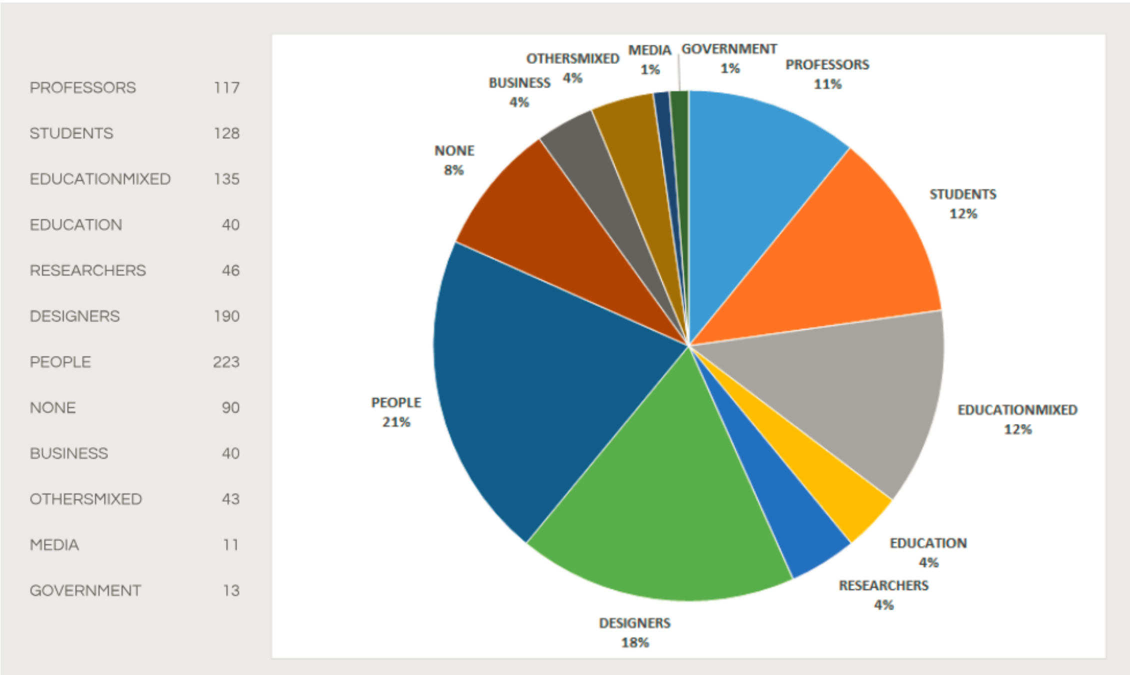
Top video uploaders were universities (21%), education related channels (15%), media channels (14%) and business channels (12%), as shown in Figure 22 (the number in the right represents number of videos). These numbers are consistent, as 612 videos (56.87%) were found to be university related, which is slightly more than in the case of SDEN.

Figure 22. Uploaders of SDES



As for top speakers, Figure 23 shows that 21% were identified as people, 18% as designers and 12% were categorized as students and education mixed (the number at the right represents number of videos classified according to speaker). This implies that education related actors might collaborate more with other stakeholders than in the case of SDEN videos. The percentage of student appearance in the video is almost equal to the one in SDEN (13%). Also, 8% of videos did not feature a speaker, which is the same percentage of SDEN and reinforces the assumption of a strong human component in the communication of sustainable design.

Figure 23. Speakers in SDES



11.2.2 YouTube Metrics in SDES

Table 15 shows the YouTube Metrics for SDES. Average of likes is 20.51 times bigger than number of dislikes, while average number of views was 3,460.09 times bigger than number of comments. It should be noted that average of likes was not as big as in the SDEN data set, while the difference between the average number of views and average number of comments was bigger in the SDES data set. This suggests that videos SDES videos are less popular.

Table 15. Descriptive statistics for YouTube metrics in SDES

Metric	Mean	Std. Deviation	N
Number of views	6674.519	47359.3123	1076
Number of likes	20.963	155.2339	1063
Number of dislikes	1.022	7.9890	1063
Number of comments	1.929	16.3049	1075

A descriptive analysis was performed on 10 SDES top videos in terms of YouTube metrics (details on the videos can be consulted in Annexes 12 to 15). The 10 most viewed videos mostly showed architecture tutorials and a few industrial design prototypes and real products. Videos were uploaded by business, media and undisclosed channels, where in three videos, there was female presence. Most videos uploaders were located in Mexico. There were three designers and three business related speakers, with two videos showing female presence. Only two of the videos were university related, which was similar to SDEN's case.

The 10 most viewed videos related to universities were mainly architecture documentaries and industrial design prototypes from various locations. There was female presence among uploaders of four videos and only one channel belonged to a university. As for speakers, four were designers, two students and there was female presence in one video.

The 10 most liked videos were mostly architecture (including two permaculture documentaries) and industrial design examples from Mexico. There was female presence among uploaders in three videos and three videos were university related. Half of the speakers were designers, with two videos including female presence. The 10 most liked videos related to universities were architecture examples (including three documentaries about permaculture) from Spain and a video about fashion design prototypes from Colombia. There was female presence among uploaders in two videos and only one video was uploaded by a university. Speakers were mainly designers and there was female presence in two videos.

The 10 most disliked videos were mostly industrial design examples and products from Mexico, uploaded by media channels. There was female presence among uploaders in two videos and only one video was uploaded by a university. Speakers were mainly designers and there was female presence in three videos. The 11 most disliked videos related to universities were architecture examples (including two permaculture documentaries) and a documentary about paper recycle, mostly uploaded from undisclosed locations. There was female presence among uploaders in three videos, while most videos were uploaded by students, one video was uploaded by a university and TEDx talks contributed with a video about urban design. Most speakers were designers and there was female presence in three videos.

The 10 most commented videos were architecture examples (including one permaculture documentary) from undisclosed locations. Three videos counted with female presence among the uploaders and most videos were uploaded by business. There was female presence among speakers in two videos and most speakers were designers. Three videos were related to universities.

The 11 most commented videos related to universities were architecture examples (including three permaculture documentaries) from various locations. Most videos were uploaded by universities and education related channels, while there was female presence in two videos. Two videos from universities had self-promotion undertones. Speakers were mostly designers and people, while there was female presence in two videos. It should be noted that several of the top videos in terms of YouTube metrics were focused on products for children.

Spearman correlation was conducted between the YouTube metrics (details can be found in Annex 16). Number of views was correlated ($p \leq .01$) with number of likes (.76), number of dislikes (.49) and number of comments (.48). Correlations were smaller than in SDEN, which can be partly due to the lower interaction with Spanish videos. Nevertheless, number of views was also selected as proxy for popularity when conducting most of the other analyses.

11.2.3 Mann-Whitney Test U in SDES

Table 16 shows some differences ($p \leq 0.05$) between the university unrelated group ($N=464$) and related group ($N=612$). Number of views ($Mdn1=583.26$, $Mdn2=504.56$, $U=121214$), likes ($Mdn1=563.26$, $Mdn2=508.34$, $U= 124229$) and comments ($Mdn1=555.84$, $Mdn2=524.50$, $U=133418$) had higher ranks in the university unrelated group; while dislikes did not show significant differences. This can be interpreted as more popularity with videos that are not related to universities, in similar terms with SDEN.

Table 16. Summary of Mann-Whitney Test U in SDES.
The Complete Test Results can be Consulted on Annex 17.

	University Related?	N	Mean Rank	Sum of Ranks
Number of Views	No	464	583.26	270634.00
	Yes	612	504.56	308792.00
	Total	1076		
Number of Likes	No	458	563.26	257972.00
	Yes	605	508.34	307544.00
	Total	1063		
Number of Comments	No	463	555.84	257354.00
	Yes	612	524.50	320996.00
	Total	1075		
Country Argentina	No	464	554.61	257340.00
	Yes	612	526.28	322086.00
	Total	1076		
Country Chile	No	464	527.59	244804.00
	Yes	612	546.77	334622.00
	Total	1076		
Country Colombia	No	464	505.31	234466.00
	Yes	612	563.66	344960.00
	Total	1076		
Country Mexico	No	464	520.26	241402.00
	Yes	612	552.33	338024.00
	Total	1076		
Country Spain	No	464	523.35	242836.00
	Yes	612	549.98	336590.00
	Total	1076		

Design areas did not show significant differences, which suggests convergence among stakeholders related to sustainable design. Chile (*Mdn1=527.59, Mdn2=546.77, U=136924*), Colombia (*Mdn1=505.31, Mdn2=563.66, U=126586*), Mexico (*Mdn1=520.26, Mdn2=552.33, U=133522*) and Spain (*Mdn1=523.35, Mdn2=549.98, U=134956*) showed a significantly higher rank on videos related to university; while Argentina (*Mdn1=554.61, Mdn2=526.28, U=134508*) had significantly higher ranks on videos unrelated to universities. This suggests that universities in Chile, Colombia, Mexico and Spain are more active than other interest groups in such countries, while other stakeholders outside academia in Argentina are more involved on the diffusion of sustainable design in YouTube.

11.2.4 Network Centralities in SDES

Table 17 shows the results of network analysis in SDES. Number of connected components, number of shortest paths, betweenness, closeness, degree and clustering coefficient are lower; while modularity and average path length are higher than in the SDEN data set. This suggests a graph composed by lowly connected clusters.

Table 17. Network centralities in SDES

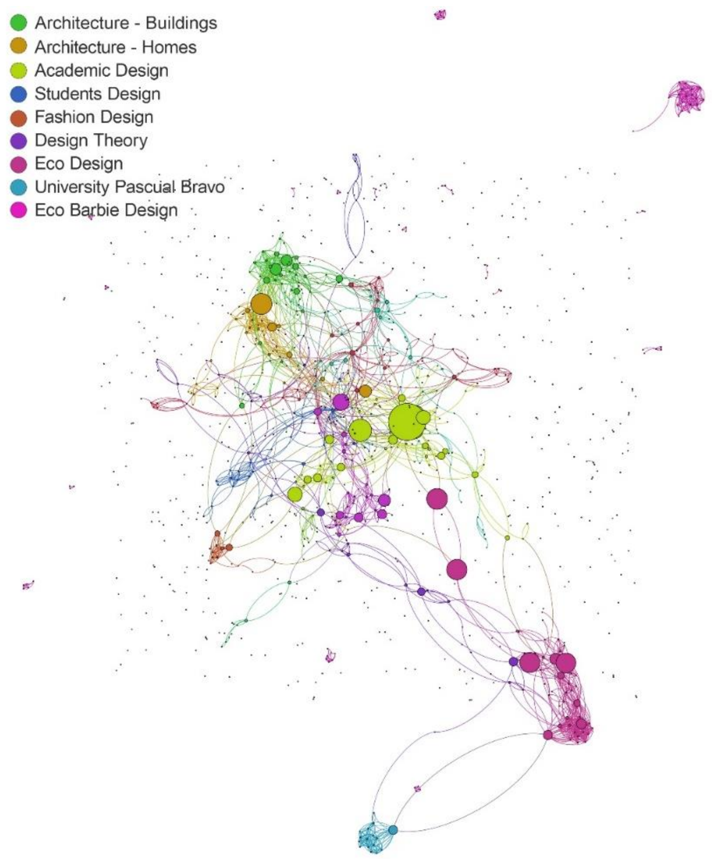
Metric name	Value
Number of nodes	1076
Number of ties	2155
Connected Components	464
Density	0.002
Diameter	21
Modularity	0.816
Average Path Length	7.11
Number of shortest paths	68340
Betweenness	388.08
Closeness	2.817
Clustering Coefficient	0.044
Degree	2.003

A descriptive analysis was performed on SDES top videos in terms of indegree and outdegree (Annexes 18 and 19). The 10 videos highest on indegree centrality were mostly about integrated views on architecture. There was female presence among uploaders in 1 video and uploaders were mainly from Spain; while there was female presence among speakers in 2 videos. 6 channels were university related. The 8 videos highest on indegree centrality and related to universities were mostly about architecture theory and prototypes. There was female presence among uploaders in 2 videos, and uploaders were mainly universities and students; while there was female presence among speakers in three videos.

The 13 videos highest on outdegree centrality were mostly about general sustainable design and architecture theory. There was female presence among the uploaders in one video and uploaders were mainly universities and people; while there was female presence among the speakers in six videos. 6 channels were university related. The 9 videos highest on outdegree centrality related to universities were mostly about architecture and mixed design areas theory and integrated views. There was female presence among uploaders in one video and uploaders were mainly universities in Colombia and Mexico. 6 videos counted with female presence among speakers, and speakers were mostly related to education. Also, in contrast with SDEN, there was no high interaction on Spanish videos with a high indegree or outdegree.

A graph was drawn to visualize SDES clusters and the connections between them (Figure 24). Node size reflects betweenness centrality from a value of 21878.635 to 0. The network was arranged through the Force Atlas algorithm, its nodes colored with the Markov Cluster algorithm. Several small disconnected groups and many isolated videos are visible.

Figure 24. SDES Graph Reflecting Betweenness Centrality (21878.635 to 0)

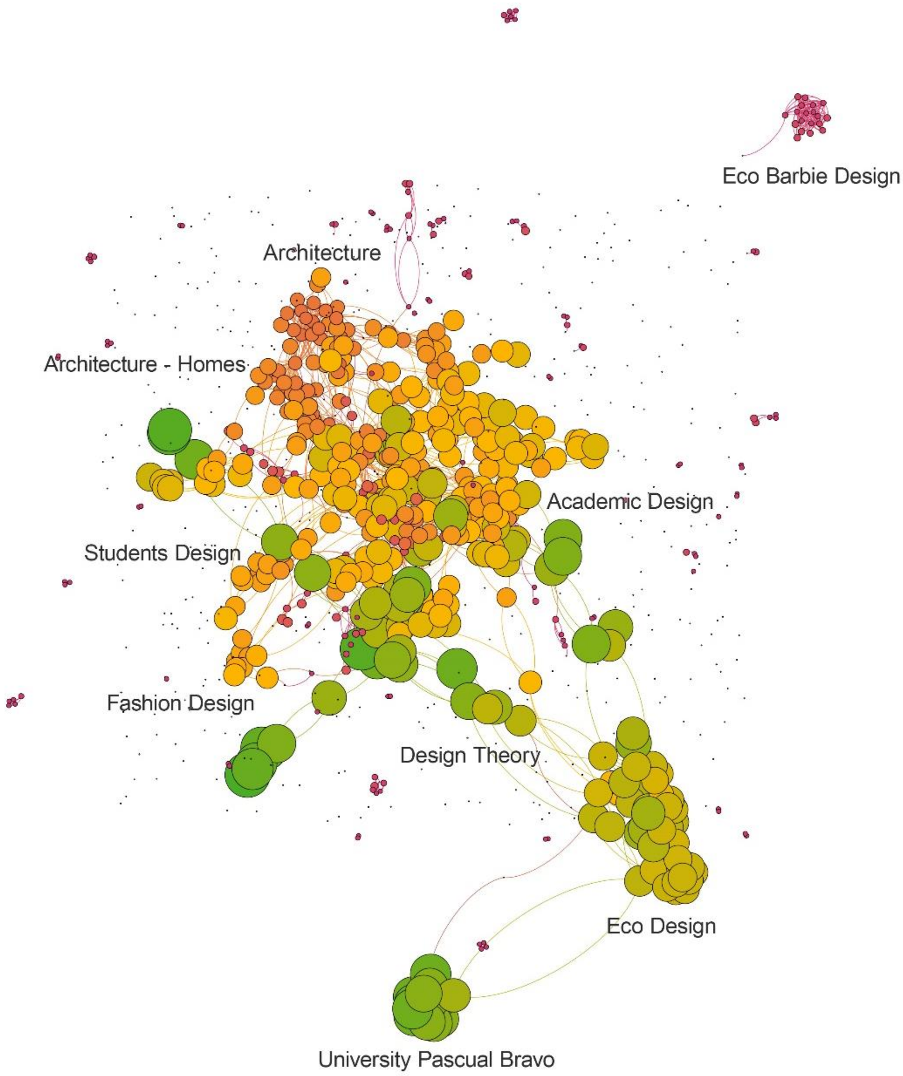


It can be noted that academic design related videos (colored in light green) is a loose cluster connected with architecture related videos and videos about students (colored in blue). The term *Eco Diseño* (Eco Design) was so relevant that it has its own cluster, connected with the academic design cluster through two videos. The first one was a video about industrial design uploaded by a student in Argentina, and the second one was multidisciplinary focused on fashion, uploaded by a media channel. There was also a cluster of fashion videos uploaded by the University Pascual Bravo in Colombia, and an isolated cluster for toys based on the American Barbie doll, also from Colombia.

A descriptive analysis was performed on SDES top videos in terms of betweenness (details can be consulted in Annex 20). The 10 videos highest on betweenness centrality were mostly about prototypes belonging to mixed design areas. There was female presence among uploaders in one video and uploaders were from Argentina and undisclosed locations. Half of the speakers were education related, there was female presence among speakers in four videos and four channels were university related. The 10 videos highest on betweenness centrality related to universities were mainly about industrial design theory and integrated views. There was no female presence among uploaders and uploaders were mostly universities. As for speakers, they were mainly education related and there was female presence among them in two videos.

It was also noted that, in similar lines with SDEN, closeness centrality was higher than degree. Thus, a graph based on the Force Atlas algorithm was drawn (Figure 25). Node size represents closeness from a value of 12.509 to 0. The cluster related to the University Pascual Bravo showed high closeness. Other big nodes located in the left down side from the design theory cluster belong to ecovillages and permaculture related architecture, while big nodes connecting the academic design cluster with the eco design cluster represent videos about eco innovation. Also, big nodes connecting the design theory cluster with the eco design cluster represent videos about design with cardboard. As for the big nodes close to the students' design cluster, they are courses about eco design.

Figure 25. SDES Graph Reflecting Closeness Centrality (12.509 to 0)



A descriptive analysis on top videos in terms of closeness was performed as well (details can be consulted in Annex 21). The 11 videos highest on closeness centrality were mostly about projects and prototypes on the architecture area. There was female presence among the uploaders in one video and uploaders were mainly business. Four videos were university related and there was female presence among speakers in four videos. The top 10 videos on closeness centrality related to universities are mostly about prototypes and methodology on the mixed and architecture areas. There was no female presence among uploaders, who were mainly universities from Colombia. As for speakers, there was female presence in six videos.

11.2.5 Node Level T-test in SDES

Table 18 shows differences between the university related group and unrelated group at node level. Only local clustering coefficient was significantly different ($p<0.05$), which implies that the university related videos have more potential of becoming a group with related videos, and thus have more potential to be linked. Taking on account the centralities that were significant in SDEN, indegree, outdegree and local clustering coefficient were chosen as network metrics for SDES to conduct further analyses.

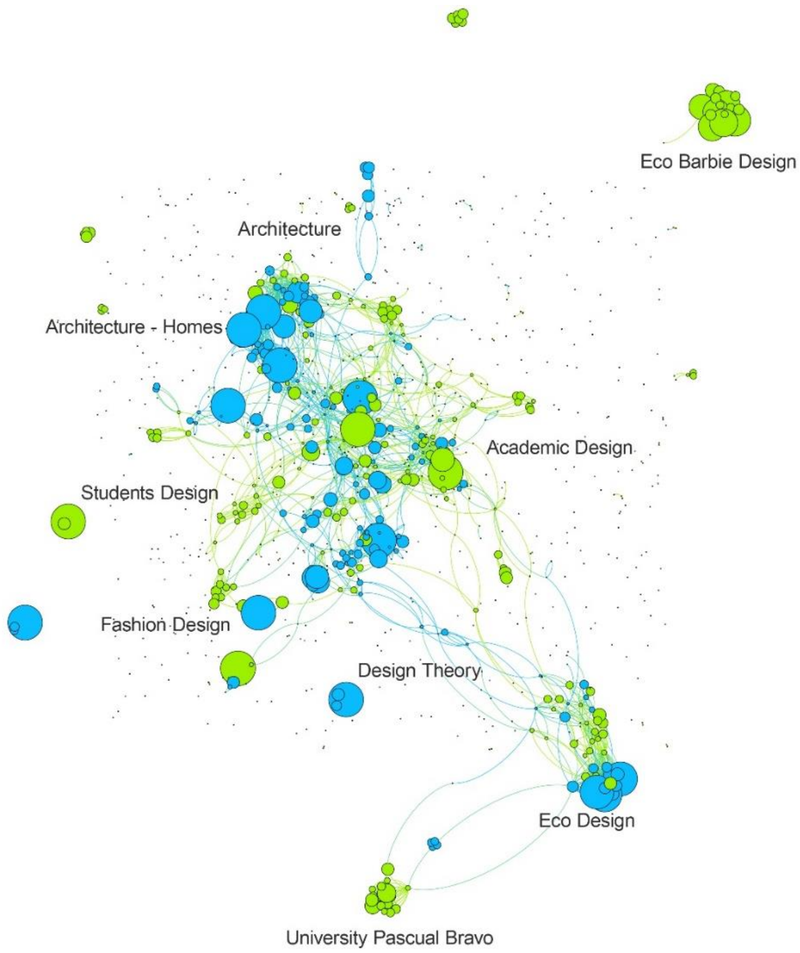
Table 18. Node level T-test in SDES. Significant differences are marked with asterisks

	Degree			Out Degree	
	Unrelated to University	Related to University		Unrelated to University	Related to University
Mean	4.067	3.925	Mean	2.010	1.994
Std. Dev.	6.155	5.843	Std. Dev.	2.853	2.820
Means Dif.	0.142		Means Dif.	0.016	
T-Test	0.7074		T-Test	0.9302	
	Closeness			Betweenness	
	Unrelated to University	Related to University		Unrelated to University	Related to University
Mean	2.783	2.862	Mean	344.358	445.750
Std. Dev.	3.306	3.285	Std. Dev.	1482.222	1493.822
Means Dif.	-0.079		Means Dif.	-101.392	
T-Test	0.6961		T-Test	0.2702	
	Clustering Coefficient			Local Clustering Coefficient	
	Unrelated to University	Related to University		Unrelated to University	Related to University
Mean	0.160	0.152	Mean	0.039	0.051
Std. Dev.	0.277	0.256	Std. Dev.	0.074	0.098
Means Dif.	-0.009		Means Dif.	-0.012	
T-Test	0.6007		T-Test	0.0283*	
	Eccentricity			In Degree	
	Unrelated to University	Related to University		Unrelated to University	Related to University

Mean	5.266	5.692	Mean	2.057	1.931
Std. Dev.	6.392	6.539	Std. Dev.	3.741	3.574
Means Dif.	-0.425		Means Dif.	0.126	
T-Test	0.2825		T-Test	0.5885	
Independent variable: University Related. Number of objects: 612, 464. Number of permutations: 10 000. Random seeds. Results marked with (*) are significant.					

A graph exploring the relationship between the university related and unrelated groups, and local clustering coefficient was drawn through the Force Atlas algorithm (Figure 26). Node size reflects local clustering coefficient from a value of 0.5 to 0, university related videos were colored in green and unrelated videos in blue. Two assumptions can be stated through this graph: 1) The design theory cluster (courses through internet and/or provided by stakeholders outside academia) connects the academic design and students design cluster; and 2) Videos in the Eco Barbie cluster are among the best connected within their own group.

Figure 26. University Relationship and Local Clustering Coefficient in SDES (0.5 to 0)



11.2.6 QAP Correlations In SDES

QAP results are shown in Table 19, where correlations are shaded in green and slight correlations, in yellow. As in the case of SDEN, there were no strong correlations between the categorical and ordinal variables, between categorical variables and network centralities, or with number of views.

Table 19. QAP Correlations in SDES

Variables		1	2	3	4	5	6	7	8	9	10	11	12
number of views	1	1	0	0.001	-0.002	0.005	0	0.001	0.002	-0.003	0.003	0.003	0.007
uploader area	2	0	1	0.039	0.019	0.007	0.006	0.089	0.154	0.021	-0.004	-0.005	-0.008
speaker area	3	0.001	0.039	1	0.131	-0.003	0.003	0.027	0.095	0.008	-0.018	-0.01	-0.009
speaker gender	4	-0.002	0.019	0.131	1	0.003	0.001	0.003	0.017	0	-0.007	-0.005	-0.009
year	5	0.005	0.007	-0.003	0.003	1	0.005	0.001	0.001	0.004	-0.002	0.003	0.005
month	6	0	0.006	0.003	0.001	0.005	1	0.002	0	0.003	0.005	0.003	0.004
country	7	0.001	0.089	0.027	0.003	0.001	0.002	1	0.033	0.009	-0.016	-0.006	-0.007
university related	8	0.002	0.154	0.095	0.017	0.001	0	0.033	1	-0.001	0.005	0.002	-0.004
design area	9	-0.003	0.021	0.008	0	0.004	0.003	0.009	-0.001	1	-0.031	-0.023	-0.024
local clustering coefficient	10	0.003	-0.004	-0.018	-0.007	-0.002	0.005	-0.016	0.005	-0.031	1	0.526	0.527
outdegree	11	0.003	-0.005	-0.01	-0.005	0.003	0.003	-0.006	0.002	-0.023	0.526	1	0.481
indegree	12	0.007	-0.008	-0.009	-0.009	0.005	0.004	-0.007	-0.004	-0.024	0.527	0.481	1
N=1076, P<0.005													

11.2.7 Outlink Analysis in SDES

An analysis of links outside YouTube for top 95 videos in terms of number of views was also conducted in SDES. Table 20 shows the most frequent domains in which SDES videos were shared. It can be noted that Facebook and other social networks were frequently used, in similar terms with SDEN. However, very few Spanish videos were shared in comparison to the English data set, which might have a relevant impact in their popularity.

Table 20. Outlink Analysis of 95 Top SDES Videos

Domain	Number of Video Shares
www.facebook.com	10
es-la.facebook.com	7
www.taringa.net	4
www.vidinfo.org	3
mx.answers.yahoo.com	2

12 DISCUSSION

12.1 Individualities, Locations, Activities And Relationships In SDEN

According to the model for online video's context (see Figure 4 for reference), the discussion will start with the individuality dimension. Several firms were involved in the diffusion of sustainable design through YouTube. For example, the Autodesk software company did several appearances throughout the videos, hosting webinars, symposiums, awards, online lecture series about sustainable design and engineering, etc.

The *Eco Marathon* is an annual activity sponsored by the multinational oil company Shell, challenging students across continents to design energy efficient vehicles since 2008. Originally called *Mileage Marathon*, it started as a competition for Shell employees in 1939, accepting participation of university students since 1979 due to a peak in environmental concerns related to fossil fuels (Carlson & Millay, 1970; Wellington, 1982). The technical advancement of the marathon has been remarkable, and its migration to social media platforms has kept it as a popular alternative of collaboration between engineering academia and a company. However, it is not clear how much the benefits of the Marathon have spilled into the car industry, and there is some indication that it is only conducted for Greenwashing (Franta, 2018).

Among media related actors, the TED channels had the objective to promote Technology, Entertainment and Design (TED Conferences LLC, 2017). TED videos have become popular in YouTube as well, as multiple official and non-official channels appeared in SDEN. In terms of non-profit media, The Story of Stuff channel was noted, particularly the video *The Story of Electronics*. The environmental activist with connections to Green Peace Annie Leonard is behind the project, releasing results of her research on product life cycle through cartoons and live action short films with subtitles in multiple languages. The channel is sponsored by grants from private and public foundations, sales of educational materials and online contributions (Story of Stuff Project, 2016). Moreover, their videos were designed by *Free Range*, a firm based in California. Other noted educational channels with non-profit intentions were found in the Engineering area, like *Engineers without Frontiers* and *Engineering Explained*.

As expected based on the literature review, universities from Australia, UK and the US were among the top in global rankings and in web visibility, partly because their citizens are among the best connected in terms of internet. US and UK are also considered in the Green Metrics top countries. Thus, expectations of finding such countries' universities relevant role in the YouTube video networks were fulfilled. The concept of the open university has become popular among universities found in the SDEN network as well, hosting public lectures and discussion panels where the public can engage with experts and other stakeholders.

Regarding countries with more diverse stakeholders, Canada has been pushing Sustainability Standards particularly for graphic design and has been active promoting them with seminars (e.g. Society of Graphic Designers of Canada, 2016), although diffusion of such activities and standards has been limited. Netherlands was the original headquarters of the Shell company, while India suffers from a lack of connection between universities and industry due to the impractical and exclusive nature of its education (Krishnan, 2016).

The numerous links found between videos uploaded by universities, companies and media channels might partly point to a complex perception of sustainable design by the viewers. Because they were more likely to have suggested videos involving a set of varied actors, this might enrich their impressions. Moreover, top popular videos tended to show complex content applied to real life problems. Even pilot projects in architecture and industrial design involved detail and system thinking. Also, most commented videos related to universities involved theory and methods, besides presenting concrete and complex examples. In sum, results suggest an acceptance of complexity by video viewers.

There is another factor influencing the interrelation of universities with other stakeholders. Fossil fuel companies have boosted their investment in renewable energy in recent times (Reiche, 2010; Berke, 2017). That is why it makes sense that companies would invest in advertisement, which would push their YouTube videos to the most visible places and thus get more views. However, such cases can easily become greenwashing if transparency and inclusion in decision making processes are not practiced correctly.

Designers at the individual level do not only focus on educational and/or professional practices, but count with media channels (sometimes their own) to diffuse their activities. The YouTube video network frequently showed famous designers from Australia, Denmark, Germany, Italy, Switzerland, UK and the U.S. Among non-designers, a women biologist and a science writer, and a male artist from the U.S. were found often. However, the implications of having mostly WEIRD countries role models is a lack of creative diversity and representation.

Regarding the type of design activities found, certifications like LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method), although voluntary, have been widely diffused among the architecture field in the last decades. Also, architecture related actors worked in collaboration with urban planning, engineering and energy experts in the videos. Many schools are renewing their campuses to incorporate sustainable architecture principles, although most videos were unrelated to universities probably because there is a high environmental concern among building industry representatives (Morton et al., 2011), aided by manager's knowledge and government support (Zuo et al., 2012).

There is some evidence that relationships among architects and engineers tend to be transnational because they have a sense of belonging to the same group that is influenced by associations, which fosters cooperation in future projects (Kennedy, 2004). Thus, sustainability on architecture has been amply covered and established, as reflected in the quantity of videos found. In contrast, designers perceived limited ability to associate with other professionals related to their field might be one of the most relevant factors behind the reduced diffusion of sustainable design in other areas. Therefore, fewer videos show sustainability practices in industrial design, graphic design, etc.

Urban sustainable architecture still faces great challenges. Population concentration in cities and climate change demand resilience in structures, social justice and a further interdisciplinary approach to solve architectural issues. There is also ample room for opportunity to integrate other design disciplines in this area.

It should be noted that the sustainability approach shown in SDEN videos is to engage technology, as it is rarely considered to leave or use habitat and materials as they are. As most videos come from WEIRD countries where technology is more accessible, cheap and advanced, such results were expected. However, an excessive dependence on technology can affect the design process itself, distancing it from its original problem-solving objective and concentrating instead on solving issues of technological process (Tonkinwise, 2014).

Moreover, feminist technoscience scholars consider that neutral science transformed into technological applications which are applied in "good" or "bad" ways is a misconception, as the researcher (or developer) always has a hand on it, entangled with social interests which enable technology to be hold politically and ethically accountable (Asberg & Lykke, 2010). Therefore, by extension, design products and services should also be politically and ethically accountable, instead of just being admired for their advanced technological features. Finally, the intersection of sustainable design and kansei was only found in UK on the General area (University of Brighton, 2012; University of Wolverhampton, 2014), as this study field is not widely diffused.

Regarding findings related to gender and activities, the number of videos with women speakers in each design area in terms of professional designers, university professors and university students was compared (Table 21). A Chi-square showed that differences between the three types of women speakers in the 5 areas were significant ($p<0.005$). With the exception of designers in the Mixed area and students in the Industrial Design area, all other areas showed a gender gap, which is in favor of female presence only in the case of students.

Gaps between designers and professors coincide with surveys conducted in the Architecture field (Río Merino, 2009; Hill, 2015), but they show more male students than female. This disparity might suggest that YouTube is overrepresenting women students in the Sustainable Architecture area, taking on account that 51.68% of such videos are from the U.S. Unfortunately, no specific surveys to compare parity in Industrial Design were found. As for the Mixed area, it showed segregation in engineering (with more male presence) and fashion design (with more female presence), while there were no craftswomen but a few craftsmen, male fashion designers and female engineers. Therefore, segregation was not extremely acute.

Another reason for numerous female students' presence might be that they are more interested in sustainability than men and/or that women students from other fields are collaborating more actively in projects than men. This is supported by Table 21's General area section (which includes multidisciplinary design). There were 33 videos with female student presence vs. 12 only including male students, which means that female student presence was over two times higher.

Table 21. Number of Videos With and Without Female Presence in SDEN

	Architecture Area		General Area		Mixed Area		Industrial Design		Graphic Design		All Areas	
	Only male Presence	Female Presence	Only male Presence	Female Presence	Only male Presence	Female Presence	Only male Presence	Female Presence	Only male Presence	Female Presence	Only male Presence	Female Presence
Designers	303	75	68	24	36	30	24	8	12	6	443	143
Professors	206	72	67	37	75	28	39	9	17	10	404	156
Students	39	81	12	33	17	34	63	66	4	10	135	224
$X^2(8) = 58.18, p<0.005$												

The discouragement towards women taking leadership positions in academia and industry should also be taken in account. Given that gender equality is a topic deeply interlinked with sustainability, it would be worthwhile to confirm the reasons why apparently there are more female students related to sustainable design in further studies.

12.2 Individualities, Locations, Activities and Relationships In SDES

Few individual speakers were present on several media channels simultaneously in SDES. They included three professional designers from Argentina and Spain. The only frequently shown stakeholder unrelated to design was a technology writer from Mexico.

Regarding locations, Argentina was among the most sustainable Latin American countries in terms of air quality, eco efficiency, human sustenance, natural resources management and water quantity (Esty et al., 2005). It also had one of the top internet penetration rates and one of the highest social media usages in the world (Kemp, 2016). Moreover, it was among the Top 15 countries with active YouTube users (Statista, 2016); hence its prominent presence in YouTube videos unrelated to universities.

In the 90's, both Argentina and Chile reformed university education to integrate design to society, production and economy through upcycling (Hinrichsen, 2008). The results are well reflected in YouTube in the case of Argentina but not so obviously in Chile. This is where the role of governments in Chile, Colombia, Mexico, and Spain (compromised with sustainable development) should be explored. They have developed programs to aid universities on this area, supporting alliances with other stakeholders while universities focus their educative programs toward complexity (Tobón, 2008; Abello Llanos, 2010; Gómez Barrera, 2010). This might be one of the reasons why, in terms of video content, more synergy between education related citizens and other stakeholders was found in comparison with SDEN.

There was few synergy between universities and other stakeholders in the SDES video network, as shown in the Node level T-test results. These tests also suggest less connection between universities from the same country. This could affect the perception of video viewers, who would tend to have less related videos on their feeds and less local-based content.

In terms of content, a concern among designers is the distinction between design (which implies a deep reflection) and stylization (superficial beautification). Although design as stylization was present in SDEN, the considerable number of discarded videos related to stylization in SDES suggests that the word *design* is strongly connected to beautification in Spanish. This might be influenced by the low technification of design in the majority of Spanish speaking countries, where design tends to be hand-made and perceived in less professional terms.

This view is also reflected in architecture videos, where permaculture was a constant topic. Documentaries like *El barro, las manos, la casa* (*The clay, the hands, the house*) and recorded experiences of students in ecovillages like Gaia showed a direct contact with raw materials and step-to-step guides to create sustainable construction integrated with nature. Although there is a deep divide between urban and rural architecture in Latin American countries (The Autodesk Foundation, 2016a), what YouTube viewers are seeking is a return to the rural. Even developed countries are starting to give attention to the importance of rural oriented design (The Autodesk Foundation, 2016b).

Another consequence of a focus in rural architecture was a greater number of videos showing houses, probably driven by prototypes built by universities (Ministerio de Vivienda y Urbanismo [MINVU], 2000), and the participation of architects with cooperatives and NGOs (Müller, 2008). Although Shell Eco-

Marathon was present on SDES, the videos number was small and there were other marathons like the Solar decathlon, with the objective of designing houses and kitchens. Again, the focus on housing rather than buildings is prominent in SDES. As for Kansei and sustainable design, there was just one video about this intersection, in the realm of architecture (e-Tecma Learning, 2013).

On regards to the Industrial Design area, there was more attention for children products than in the SDEN network. For example, there were Barbie toy prototypes and toy-tools to recycle. One of the reasons might be that population in Spanish speaking countries tends to be younger than in the case of English-speaking countries (Central Intelligence Agency [CIA], 2017). Many of the videos were uploaded from Colombia, where there is a solid legislative framework to aid childhood and early development (Cálad Idárraga, 2013), which fosters interdisciplinarity with their similarly solid design legislative framework.

As for the Mixed area, fashion is closely related with the textile sector and small and medium businesses which, again, are being supported by governments and industry through several cooperative programs in the case of Colombia (Gomez-Barrera, 2010). Thus, videos related to fashion and Colombian universities were popular. There is also a tendency among Latin American brands to seek collaboration with indigenous groups, enhancing the fair-trade philosophy and incorporating heritage (Cortes Lefranc, 2017). This has the additional effect of empowering the concepts of brand in crafts, and of countries as brands.

Design is part of the *Orange Economy* (Buitrago Restrepo & Duque Marquez, 2013), another name for creative economies diffused in Spanish speaking countries, often as an integral part of tourism strategies (Tresserras Juan, 2017). However, there should be caution when there is lack of regulation or abuse in terms of intellectual property, as it is often the case in Latin American countries (Torres, 2012; Picq, 2017). Moreover, an excessive demand of tourism industries can burden both the environment and the humans related to it.

The SDES video network was underdeveloped in comparison with SDEN, as shown in the Node level T-test, where the few connections between universities and other stakeholders were noted. Among the reasons is the lacking internet infrastructure in Spanish speaking countries, while the availability of easy internet access has flooded the web sphere with content from developed countries. However, psychological aspects should not be ignored. There is a tendency by Latin American YouTube users to comment on English videos, while English speakers rarely comment on Latin American videos (Duarte et al., 2007). Restrictions on broad band might trigger Spanish Speaking viewers to comment only if necessary, thus choosing the videos they consider the best to comment.

English is widely accepted as the default language for most of the important issues in the contemporary world, including the internet; however, that implies introducing pedagogical and cultural aspects that contribute to the devaluation of local knowledge and cultures (Guo & Beckett, 2007). Therefore, we have three elements playing a part on the low interactivity in the SDES networks: a) the larger availability of English videos in YouTube; b) algorithmic bias towards English content; and c) a perception of Latin American design contents and methods as inferior by both English and Spanish speakers. This could be called a *perception of virtual colonialism*, borrowing the extension of colonization to the internet explored by Hall (1999) and Ameli (2010).

There is also a tendency in developing countries users to choose social media tasks that are faster to complete and thus cover more diverse topics in an internet session than developed countries users (Vargas Meza, 2014). Although YouTube was available for Spanish speaking countries since it launched, relevant videos of the SDES data set were dated from 2007 instead of 2006. This suggests that relevant videos get outdated faster than SDEN videos, which implies that viewers are keener to seek novelties. Nevertheless, connected videos in the SDES network were related to universities, students and people.

The term *Ecodiseño* was so relevant for the Spanish network that it had its own cluster. The diffusion of this term was partly aided with the ISO Norm 14006, which provided an official definition for *Ecodiseño* in 2011. However, this result suggests that some Spanish speaking viewers might only be exposed to a sustainable design concept related to products. This assumption is supported by the finding that most liked content were concrete examples of a single design (e.g. a chair, a toy, a house). This is the most basic level of sustainability according to Ceschin and Gaziulosoy (2016), begging the question of how integrated is systems thinking in the sustainable design of Spanish speaking countries.

The content of top videos in terms of interactivity is more storytelling oriented than in the case of SDEN videos. Universities and professors are much less present in these videos, while the presence of Autodesk was also more modest, sharing space with the American Solidworks software. This suggests a more egalitarian perspective connected to sustainable design.

According to the literature review, developing countries tend to consume sustainable design while developed countries produce it. However, YouTube showcased a lot of production in developing countries. On one hand, this is due to a persistence on the perception of sustainable development as aid, but it is part of the *Teoría de la Dependencia* (Dependence Theory) as well, which states that Latin America functions as supplier for industrialization in developed countries, fostering the formation of endogenous oligarchical classes responsible for maintaining the domination relations subordinated to their interests (Gutiérrez Garza, 2008).

This implies that Latin American countries give a higher priority to export their products, which decreases internal demand (Marini, 1973). The consequences are perpetual poverty, corruption and lack of investment in science and technology, which are reflected in the low-tech design frequently present in the videos. Despite that low-tech is favoured by the creative communities in Latin America as a counterpoint to the highly technified North (Taylor, 2014), the afore mentioned production and consumption dynamics should not be ignored as an important driving factor of sustainable design characteristics.

There have been grassroots initiatives like local development (Casanova, 2004), human-scale development (Max-Neef et al., 2010), and solidary economy (Abramovich & Vasquez, 2007) which seek to fill the institutional gap. Other proposals incorporate indigenous knowledge like *Sumak Kawsay* or *the good living* included in Bolivia and Ecuador's constitutions, and ecological-shared economy in Mexico (Barkin & Lemus, 2011). Nevertheless, in general, there is a lack of a sustained and articulated political-economic framework that could foster design development and demand in Spanish speaking countries. Colombia is a notable exception in the region.

The larger female presence in the Spanish networks in comparison with SDEN is also to be noted. In similar grounds with SDEN, the Architecture area was the highest in terms of female speakers' presence (44%), although it was followed by the Mixed area. The number of videos with female presence in design areas was compared in Spanish as well (Table 22), finding significant differences ($p>0.05$) between the three type of women speakers in the 5 areas. General and Graphic Design areas have too few videos, although the quantities are similar to those in SDEN. The Architecture area has a similar gender gap than SDEN, although it is less acute in the case of designers. It should be noted that 25.58% of Architecture videos were uploaded from Argentina.

Table 22. Number of Videos With and Without Female Presence in SDES

	Architecture Area		General Area		Mixed Area		Industrial Design		Graphic Design		All Areas	
	Only male Presence	Female Presence	Only male Presence	Female Presence	Only male Presence	Female Presence	Only male Presence	Female Presence	Only male Presence	Female Presence	Only male Presence	Female Presence
Designers	88	43	9	8	24	23	19	18	3	2	143	94
Professors	70	17	15	7	16	16	16	6	7	2	124	48
Students	16	31	2	9	14	18	29	29	3	6	64	93
$X^2(8) = 13.53, p>0.05$												

Cirvini (2015) argues that in the past century, Argentinian women architects' production was forgotten because it was part of teamwork where male names only transcended, or because their work was anonymous as assistants in design, drawing, interior design or decoration. With the current level of access to social media, such women can self-promote easily, and if they work alone, there is a better chance to be recognized than in other design areas, as architecture is "signed" by its author.

Another reason for a numerous women presence in the architecture area is that most of the work shown in the videos was related to housing, which is an area traditionally viewed as acceptable for women (Río Merino, 2009). Although some of the design proposals attempt to recover public spaces, many are focused on materials and energy saving in one single house.

Material feminists and designers such as Jane S. Appleton, Catherine Beecher, Melusina F. Peirce, Marie Stevens Howland, Mary Coleman Stuckert, Charlotte Perkins Gilman, Alice C. Austin, Ruth Maxon Adams and Edith Elmer Wood defined the social, economic and spatial structure of cooperative houses, neighborhoods and cities, expanding and conciliating the private and public spheres of women in the times of the Industrial Revolution (Hayden, 1982). Their contributions have survived to a certain extent in space saving architecture across the globe. However, their concept of feminist shared space should be recovered and adapted into modern sustainable Architecture practice. Some theoretical approaches can be found in Hamraie (2013).

Another country that uploaded many videos was Spain. In this country, heritage conservation related to architecture has become attractive to women, including the protection of intangible heritage (Quirosa García & García Robles, 2010). Intangible heritage is not easy to preserve, as it requires a deeper analysis of the protection plan and continuous cooperation across many sectors, besides also being included in tourism strategies in Spanish speaking countries.

As for the Mixed area, it shows nearly equal number of videos with and without female presence in the case of designers and professors. There are equal number of videos showing female engineering teachers and fashion designers, while there is only one professor in fashion design compared to the rest in engineering; and most of the male students were in engineering videos while only one female student was present. However, while women were largely shown in videos about fashion and textile design, there is the same number of videos on male engineers than on craftsmen and fashion designers, revealing highly engendered activities in this design area among Spanish speakers.

The number of videos related to fashion design contained in the Mixed area is partly due to algorithmic bias benefiting Spain, which had the biggest number of videos about sustainable design in Spanish. However, this also suggests a prevalence of informal businesses and self-expression channels in social media. The attractiveness of flexible working hours, extra income and self-agency attracted women in the American continent to use internet as a promotion tool to create their small world networks amid male backlash (Wallace, 2014), but this case is especially true in Spanish speaking countries (Zafra, 2008). The nature of this hidden but highly cooperative networks of women might also partly explain the disconnected clusters of the SDES network, although other factors discussed in the previous section should not be forgotten.

Finally, the Industrial Design area showed parity in terms of designers and students. One reason might be the acceptance of women as crafters (creators) of objects in Latin America. In sum, the Spanish video sample showed a more homogenous relationship between gender and activities. However, it would be worthwhile to confirm the reasons behind these results in future studies.

12.3 YouTube And The Diffusion Of Sustainable Design

The two previous sections have mostly discussed differences between the YouTube networks. This section will explore similarities. A considerable increase of videos since 2011 according to Figures 8 and 18 point at the influence of the ISO Norm 14006 in the diffusion of sustainable design, particularly in the architecture area. Other norms have been released since then, focusing on labelling and social responsibility. However, there still is a lack of consensus on how to measure environmental impacts caused by design, particularly in the case of digital products (Hodgson, 2015).

The presence of graphic design in the networks was small, and the major type shown was web design. Such videos included topics like green internet, green tics, ubiquitous computing and human computer interaction. There are several reasons for the low visibility of graphic design. Among them, there is a lack of academic programs focused on sustainability in the graphic design area, with a notable exception among videos from Falmouth University in UK. Yet, a revision on the contribution of graphic design to the mixed and general area shows animation, packaging and, in more integrative terms, service design and system design. Therefore, the contribution of graphic design to sustainability goes well beyond paper-based products.

There was a strong human component in the communication of sustainable design in the videos, as shown in the considerable number of videos where there was human presence. The relationship of humans with nature is thus humanized, meaning that there is scarce attention and affection towards other living beings. Thus, biomimicry has not been widely diffused yet, as only 17 videos in SDEN and 5 videos in SDES had such content. The case for elimination design is even worse, present in 3 and 0 videos respectively.

The relevant role as uploaders of non-profits, art galleries, associations, award giving organizations, e-schools, forums, foundations, museums, networks, research institutes, etc., is partly due to the decline of control by the institutional design education. This mirrors tendencies by governmental institutions as well. A concentration of resources control and decision-making in a few individuals slows down the capability and speed of reaction necessary to cope with challenges in the globalized world; therefore, our hierarchical civilizations are going through a transformation process towards networked civilizations, which are more egalitarian in nature but increase individual interdependency (Koebler, 2016).

Comparisons of correlations between YouTube metrics calculated in the present study with videos from the most popular YouTube channels (Ha, 2018) reveal that correlations for both SDEN and SDES are lower. Also, the number of linking steps in the video networks were more similar to the classical social theory of the seven steps of distance than the usual three or four linking steps found in social media. Thus, although the content of most videos is highly valuable in terms of information, both networks lack popularity.

A study on learning propagation in different social network configurations found that users learn faster with high density, short mean distance between nodes and numerous paths for information transmission; and that learning benefits more from an early adoption (Veillon et al., 2017). This means that highly clustered online educational materials are more advantageous for students, and that the sooner the students assimilate new information, the better. Therefore, the uneven diffusion of educational content in YouTube hinders its original objective.

Regarding academia, some project-based videos are uploaded in YouTube accounts that are only used for that project. Moreover, the Mann-Whitney test showed more interaction with videos that are unrelated to universities and only a few countries where university leadership stands out in the diffusion of sustainable design through YouTube in both data sets. Hence, the university related YouTube channels tend to function as document repositories for the lectures, conferences and symposiums such institutions organize.

This function is reinforced by videos which were shared through other social media sites, according to outlink analysis. Many of such channels also are used as document repositories. Moreover, the top social media site for the videos (Facebook) has decreased video sharing recently (Tran, 2018). The move obeys the mitigation of fake news, but at the same time, educational contents diffusion was further compromised.

Nevertheless, this poses a question. If traditional lectures (with a theory-based speaking professor and passive students) are considered boring, why are they still carried on in modern versions like MOOCs and several of the videos found in the present study? The key might be that some surveys with students across cultures show they are more comfortable on such learning environments (e.g. Aoki, 2010; Arras Vota & García Valcárcel Muñoz Repiso, 2011; Covill, 2011), which is an attitude groomed since elementary school. However, a distinction between uninterested and active listening students should be done. Active listening enhances abilities such as initiative, focus and critical thinking with lectures. The rise in popularity of public lectures also supports this approach.

Lecturers require fine-tuned abilities to deliver the right amount of theory, methods and practice. The attention universities tend to give to publications and grants, loading teachers with workload while giving out temporary contracts and low pay are also impacting the quality of lectures (Tokumitsu, 2017). Hence the importance of a combination of educational contents and delivery methods (on- and offline) that fosters students' confidence in their own abilities, sparks their curiosity and tunes with their feelings.

Regarding students, as several of them in both networks posted videos with their prototypes and real projects, it is expected that adoption of social networks by the younger generations will continue aiding the diffusion of sustainability. Design praxis should involve efforts to close the gap between humans and nature. Specifically, in designers' relationship with their projects, the materials they use, other living beings involved and the environment, there must be congruency between thoughts, feelings and behaviours to improve the design process and, as a result, the design object.

13 CONCLUSIONS

The present study explored academic output other than global rankings, patents and research papers. Results have been discussed from a contextual perspective, including characteristics of video uploaders, speakers, uploading time, place, design activities, and relationships between videos. Regarding research questions posed in Section 8, the present study concludes that:

1.1 Based on social network analysis, the English network is organized as big clusters with multiple interconnections between videos uploaded by universities and other stakeholders, while the Spanish network is organized in small clusters with few connections between videos (even among those from the same country). However, Spanish speakers related to universities were more engaged with other stakeholders in the video content.

2.1 Based on view count, university related content was less popular than content from other sources in both languages; while English videos were more popular than Spanish videos. Meanwhile popular English content tended to show acceptance for complexity, Spanish popular content tended to be focused on a particular project or prototype.

2.2 Although architecture videos were among the most numerous and popular, they were followed by videos from the general area in SDEN, while in the case of SDES, they were followed by videos from the mixed area. This difference in activities reflects the *Teoría de la Dependencia* and a *perception of virtual colonialism*.

3.1 Based on outlink analysis, videos were frequently shared in websites that function as document repositories. Nevertheless, videos have a high potential for educational usage if they are customized to the viewers' context and if they are shared in social media which are more focused in social interaction.
3.2 According to QAP correlation analysis, contextual factors based on Zimmerman et al. were limited to explain popularity. Given that several popular videos were centred in a particular designer, other quantitative and qualitative analysis such as semantic and sentiment analysis might be able to deepen the understanding of popularity and interaction with the videos.

Research results have implications on the era of web 3.0 towards web 4.0 (fully ubiquitous), as universities should decide how to approach and use technology to diffuse their activities. Public knowledge in the case of Wikipedia is edited by 20% of the world population, mostly belonging to WEIRD countries, where it is estimated that 9 out of 10 editors are men (Bouterse & Sengupta, 2018). Although the case of sustainable design in YouTube fares better, the internet is generally more beneficious in the Northern hemisphere (see Friederici et al., 2016). Thus, a careful consideration of which activities related to sustainability to diffuse and how is advisable.

Regarding research methods, if only automatic cluster algorithms would have been used to categorize data, more in-depth information about the videos would have been omitted, pointing to the importance of using human coding, amid its relatively slow speed. Such methods are in line with feminist speculative design, which the present study is extending to analyze relationships between humans, non-human beings and the environment, proposing the field of *bio speculative design*.

CHAPTER IV: A LEXICON OF MANY VOICES. SENTIMENT, ATTITUDES AND BEHAVIOURS RELATED TO SUSTAINABLE DESIGN.

"When the block went out of the machine I felt like I had a baby, is going out, it's like wow!, it's like from my heart..."

-Majd Mashharawi (2018)

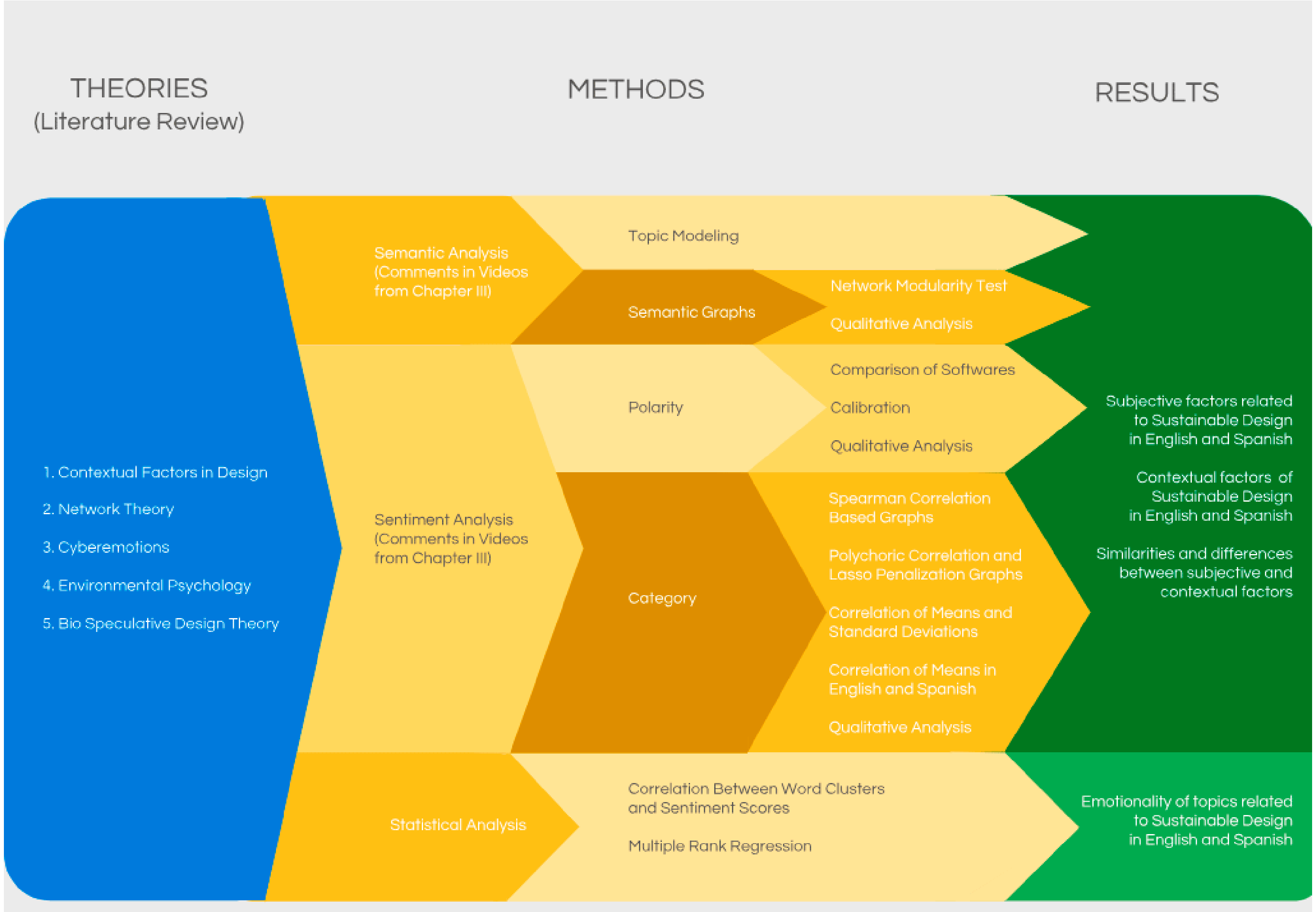
14 OBJECTIVES

Given that the previous chapter discussed limited explanations for the popularity of sustainable design videos in YouTube, this chapter aims to answer the following questions:

1. Which attitudes, behaviours and sentiments are related to sustainable design comments made in popular videos in YouTube?
2. Which contextual factors are related to pro-environmental attitudes, behaviours and sentiments; and which ones are related to barriers for sustainable design?
3. Which topics are more emotional and which ones are neutral?

The following workflow will be implemented to answer these questions:

Figure 27. Workflow for Analysis of Sentiment, Attitudes and Behaviours in Comments related to YouTube Videos



15 METHODS

15.1 Data Collection And Filtering

Databases of YouTube videos collected for the previous study were considered. 164 videos from SDEN with a value of at least one in degree and over 8,000 views were selected. Because there was low interaction with videos in SDES, 149 videos with a value of at least one in degree and over 10 views were chosen.

Videos comments were extracted using the module Video Info of YouTube Data Tools (Rieder, 2015), which retrieves comments via the commentThread/list YouTube API endpoint. Output files in excel format include basic information and statistics about the video, retrievable comments (containing comment id, number of replies, number of likes, published date, author name, comment text, author channel id, author channel link and whether the comment is reply to another comment or not), comment authors and number of their comments, and a Gephi network file mapping interactions between the authors. Only two sections of the second file's data were employed for the present study (published date and comment text).

14,538 comments from SDEN videos and 1,501 comments from SDES videos were extracted in total. There was a slightly higher data decay in Spanish, meaning that a few videos were deleted or its public access removed since data collection for the first study. After revising the comments to discard content in other languages and spam, 13,976 comments from 163 SDEN videos and 1,351 comments from 147 SDES videos were considered for the next steps of analysis.

15.2 Semantic Analysis Procedures

Because of software issues detecting non-alphanumeric characters, identifiers were assigned to each special character and graphic representation found in the texts. For example, the emoticon "☺" was substituted with "gsgrin38". Graphical representations were also classified based on similarity of their features, as can be appreciated in Figures 28 and 29:

Figure 28. The 204 Graphical Symbols in SDEN comments

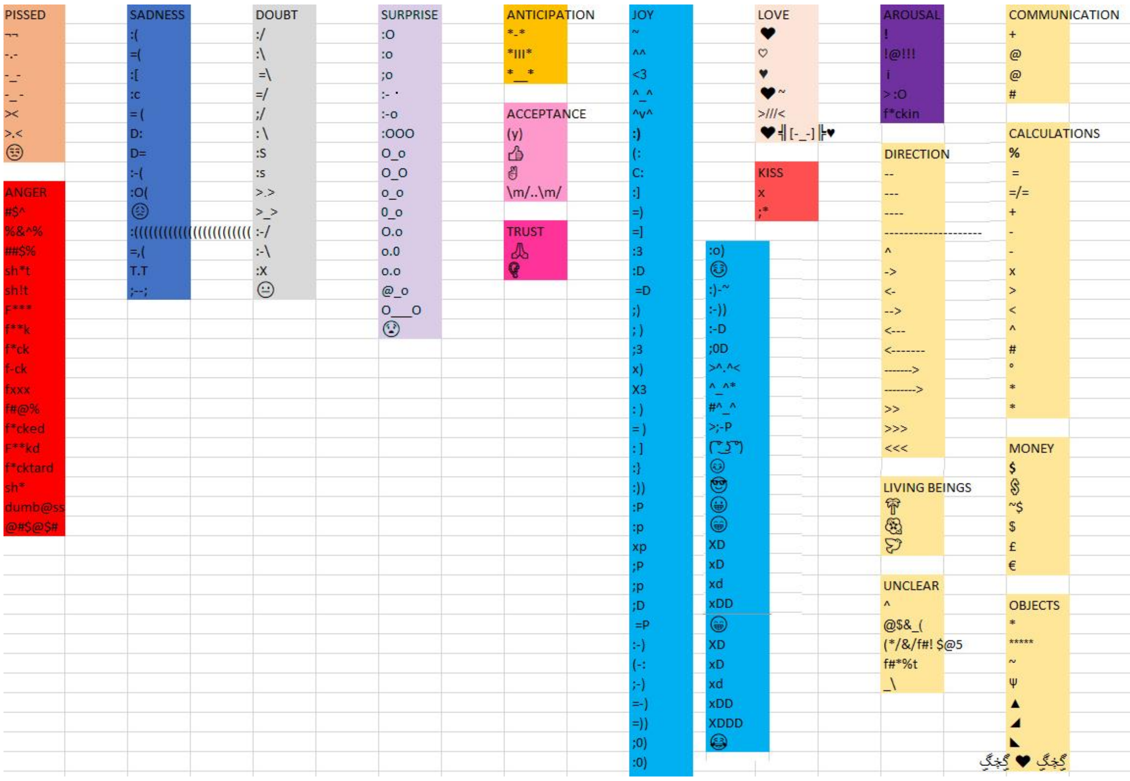
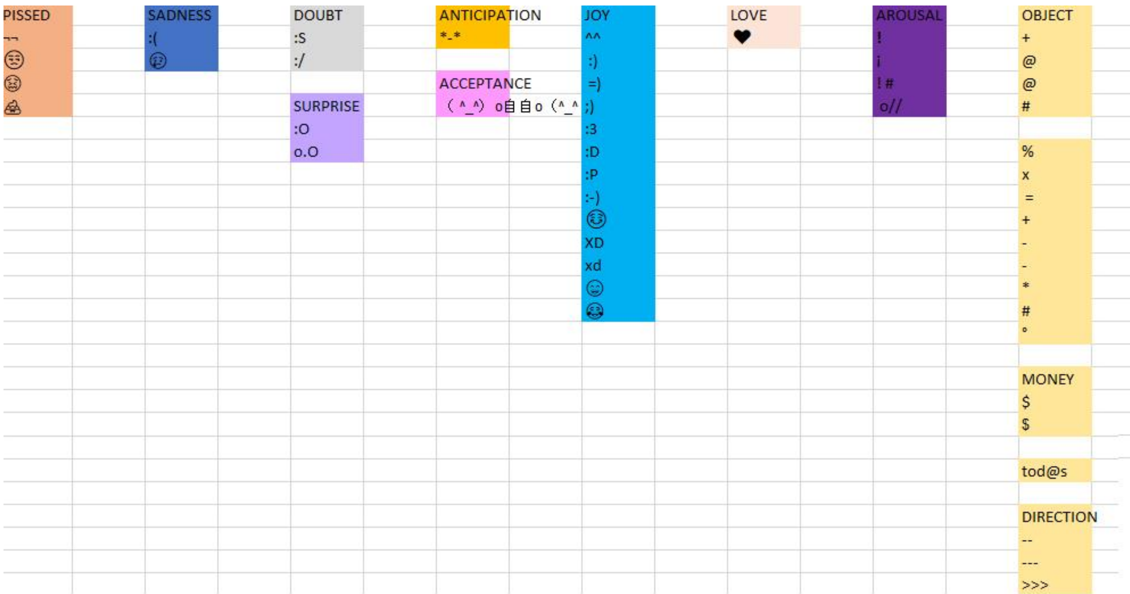


Figure 29. The 48 Graphical Symbols in SDES comments



Several identifiers were assigned to polysemic symbols. For example, @ was employed to tag YouTube users in replies, but it also was used in email addresses. In addition, a classification for frequent words was developed, shown in Table 23.

Table 23. Semantic Classification of Frequent Words

1. Subjects. Subdivided as:
• Nouns (e.g. designer, William McDonough).
• Pronouns (e.g. she).
2. Kansei words. Subdivided based on Strapparava and Valiutti (2004) as:
• Adjectives (e.g. fast).
• Attitudes (e.g. view).
• Behaviours (e.g. lol).
• Cognitive related words (e.g. know).
• Emotions (e.g. love).
• Emotionally eliciting words (e.g. fun).
• Emotional response words (e.g. enjoy).
• Moods (e.g. happy).
• Negativity related words (e.g. no, wrong).
• Physical state related words (e.g. live, die).
• Sensations (e.g. hot).
• Traits (e.g. kind).
• General, for words that fall in several subcategories (e.g. idea, believe).
3. Verbs. Subdivided as:
• Connector (e.g. have, will).
• Continuous (e.g. building, growing).
• Infinitive (e.g. build, grow).
• Past (e.g. built, grew).
4. Direct objects and Topics. Subdivided as:
• Abstract (e.g. education, law).
• Natural (e.g. animal, water).

• Unnatural (e.g. car, goods).
5. Place and Time related words. Subdivided as:
• Place related words (e.g. Japan, house). • Time related words (e.g. minute, yesterday).
6. Graphical symbols (e.g. !, T-T, 🌸).
7. Measures (e.g. meters, pounds).

ConText software (Diesner, 2014) performed topic modelling, calculated word frequencies, detected bigrams, and word co-occurrences. Topic modelling is the analysis and classification of large quantities of text data. To classify the words in topics, ConText employs Latent Dirichlet Allocation (LDA), which is based on co-occurrence of words with the topic (Reed, 2012). Although very common for topic modelling, LDA is just a first step to explore the texts content.

Word frequency analysis was conducted in iterations to detect words that might need disambiguation. For example, *americans* to represent American citizens and *american* to represent the adjective related to the US. Some words also were treated as a unigram (e.g. *rbe* instead of *resource-based economy*). There were a few disambiguation exceptions because some words were used mostly in the same part of speech. For example, *matter* was mainly used as verb. Also, the text was cleaned from characters which did not provide relevant emotional information, like points and commas. In the case of Spanish, some gendered words and plurals had to be unified (e.g. *diseñador*, *diseñadora*, *diseñadores* y *diseñadoras* became *diseñadores*). Accented vowels were replaced (*a* instead of *á*) and also special characters like the consonant *ñ* (e.g. *diseniadores* instead of *diseñadores*).

Once ConText generated two files with total word count of the texts, the classification scheme in Table 23 was applied to top frequent words. If all the words in the list were converted into a network with Gephi, it would have been difficult to explore and analyse it. Therefore, four word-lists were produced for each language:

- A-list: top 613 words in SDEN and 614 words in SDES. This list was generated to explore the most frequent contextual and subjective factors related to sustainable design.

- Negative list: top 601 words in SDEN and 486 words in SDES from the subjects, verbs, direct objects and topics, place and time, and graphical symbols categories; and the negativity related words subcategory from the Kansei words category. This list was produced to explore negative attitudes, sentiments and behaviours related to sustainable design; and to analyse barriers for sustainable design behaviours.
- 236 list: 601 words in SDEN and 424 words in SDES from the Kansei, verbs and graphical symbols categories. It included all graphical symbols found in the texts, while including only top words from the Kansei and verbs categories. This list was generated to explore the relationship between sentiment, attitudes, behaviours and graphical symbols.
- 246 list: 600 words in SDEN and 497 words in SDES from the Kansei, direct objects and topics, and graphical symbols categories. It included all graphical symbols found in the text, while including only top words from the Kansei, and topics and objects categories. This list was produced to analyse the relationship between sentiment, attitudes and graphical symbols. This step also helped to clarify which topics elicited more emotional expression.

Bigrams are pairs of words used together, without any other word between them. This means that their distance was equal to zero. A-list words in the two languages were analysed in ConText to detect bigrams, in case further iterations for word frequency analysis or other adjustments were required.

The word lists were uploaded to the ConText software to calculate word co-occurrence, which can be defined as how many times two words were used together. One-mode networks with aggregation per corpus (file) and paragraph (comment) were generated. The maximum distance between words was 14 for SDEN and 15 for SDES, according to what is considered the average sentence length in each language.

ConText produced two csv files for each network: one with information about words (the nodes of the network) and another with information on the relationships between words (the edges of the network). File pairs were compiled with Gephi to generate the networks. The exploration of networks to interpret the meaning of comments took on account context categories used in the previous chapter. This means that individuality was mostly represented by words categorized as subjects, Kansei words and graphical symbols; time was mainly represented by words in the time subcategory; location by words in the place subcategory; and activity was mostly represented by words categorized as verbs, and direct objects and topics. Once semantic analysis was completed, sentiment analysis followed, as described in the following sections.

15.3 Sentiment Analysis Procedures

Automatic sentiment analysis examines expressions of private states in text that are not easily open to objective observation or verification. For example, when a person states they are *feeling very good*, this reflects their internal evaluation, while an expression like *I am going to the school* can be easily observed and verified in an objective way. The three broad categories of automatic sentiment analysis are: a) polarity in simultaneous positive and negative scales (e.g. Thelwall et al., 2010; Paltoglou et al., 2013), b) categorical with labelled outputs such as fear and fatigue (e.g. Mishne, 2005; Strapparava & Mihalcea, 2008), and c) dimensional with a numeric prediction such as valence or arousal (e.g. Dodds & Danforth, 2010; González Bailón et al., 2012).

Cyberemotions studies have mostly dealt with sentiment polarity. However, because detecting negative emotions such as sadness and disgust is relevant for this study, categorical sentiment analysis was also taken on account.

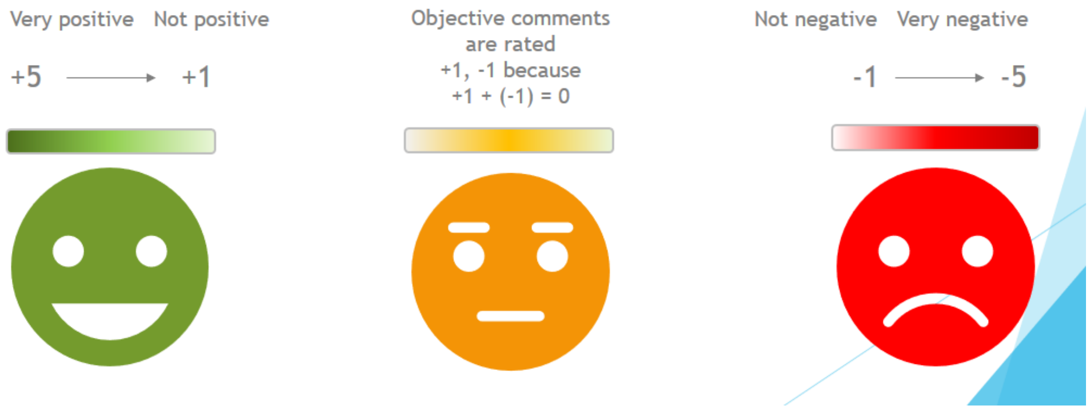
Graphical representations were treated in two ways for sentiment analysis. For the initial software comparison benchmark and the sentiment categorical tests, comments were left without change (e.g. What a lovely day for talking to my @youtubefriend 😊). For the sentiment polarity test, some of the files employed were left without change, and in others, graphical symbols were substituted (e.g. What a lovely day for talking to my gsat1 youtubefriend gsgrin5). This substitution was decided depending on how relevant the graphical symbols were for sentiment detection, which was determined by software calibration tests. This procedure will be described in the following sections.

15.3.1 Sentiment Analysis by Polarity

In studies employing polarity scales, text is rated in terms of how positive and how negative it seems to be. The output score is either composed of two numbers (one for positive polarity and the other for negative polarity), or one number (the sum of both polarities). Because the presently analysed texts tend to be long and thus express a wide variety of emotions in a single comment, it makes more sense to use two scores.

There are several freely available sentiment analysis software for academic purposes that provide polarity output. However, most texts used for calibration of these tools were too general or too political and social oriented, in contrast with creativity and design related data collected for the present study. Therefore, 100 comments from each language were chosen with a randomizer (random.org, 2017) to be evaluated by humans. A total of eleven coders with architecture, design and/or engineering background worked in pairs. Eight of them had some training in psychology, behavioural science and neuroscience. Each pair of coders rated 20 comments according to the scale shown in Figure 30. The initial Intercoder Agreement (available in Annex 22) was relatively low, as the texts were considered too subjective.

Figure 30. Polarity Scale for Sentiment Analysis



To choose the most suitable polarity sentiment analysis for the comments, a benchmark called iFeel (Araujo et al., 2016) was employed. This benchmark utilizes automatic translation for languages other than English. Moreover, instead of considering the SentiStrength (Thelwall, 2017) software version available in iFeel, a version with sentiment dictionaries for the two languages provided by the original developer was used. Once the sample of 100 comments was rated by a total of 18 tools, number of false positives, false negatives and false neutrals were counted to calculate F1, Macro-F1 and Coverage measures. F1 is the harmonic mean between precision and recall. Precision in the case of positive comments was calculated using the following formula:

$$\textit{Positive precision} = \frac{\textit{Number of true positive comments}}{\textit{Number of true positive comments} + \textit{Number of false positive comments}}.$$

Recall is a measure of how well a sentiment detection software can tell apart positivity from negativity. In the case of negative comments, it is calculated using the following formula:

$$\textit{Negative recall} = \frac{\textit{Number of true negative comments}}{\textit{Number of true negative comments} + \textit{Number of false positive comments}}.$$

Macro-F1 summarizes overall prediction performance better than accuracy in unbalanced datasets. It equals the average of positive and negative F1. As for coverage, it measures how many texts were correctly classified as positive, neutral or negative divided by total number of texts. Results of the software comparison can be consulted in Tables 24 and 25. The objective coverage refers to a revision of comments coded by humans. As several were viewed as too complex to be rated objectively, the software score was considered as a better rating in some cases.

Table 24. Comparison of sentiment detection software by polarity in English comments

	OPINIONLEXICON	SENTISTRENGTH	SOCAL	HAPPINESSINDEX	SANN	EMOTICONSDS	SENTIMENT140	STANFORD	AFINN	MPQA	NRCHASHTAG	EMOLEX	EMOTICONS	PANAST	SASA	SENTIWORDNET	VADER	UMIGON
False Negative	4	**13**	**13**	1	1	0	40	28	6	14	44	6	0	0	19	9	1	13
False Positive	28	**13**	**16**	34	10	55	9	4	24	8	3	23	1	0	23	34	14	15
False Neutrals	32	**31**	**27**	33	59	6	7	26	30	47	6	35	83	81	18	5	47	38
Positive Precision	0.6	**0.76**	**0.72**	0.55	0.80	0.43	0.82	0.91	0.63	0.84	0.93	0.64	0.97	1	0.64	0.55	0.75	0.73
Positive Recall	0.91	**0.76**	**0.76**	0.97	0.97	1	0.51	0.6	0.87	0.75	0.48	0.87	1	1	0.68	0.82	0.97	0.76
Negative Precision	0.91	**0.76**	**0.76**	0.97	0.97	1	0.51	0.6	0.87	0.75	0.48	0.87	1	1	0.68	0.82	0.97	0.76
Negative Recall	0.6	**0.76**	**0.72**	0.55	0.80	0.43	0.82	0.91	0.63	0.84	0.93	0.64	0.97	1	0.64	0.55	0.75	0.736
F1 Negative	0.72	**0.76**	**0.74**	0.70	0.88	0.60	0.63	0.72	0.73	0.79	0.64	0.74	0.98	1	0.66	0.66	0.84	0.75
F1 Positive	0.72	**0.76**	**0.74**	0.70	0.88	0.60	0.63	0.72	0.73	0.79	0.64	0.74	0.98	1	0.66	0.66	0.84	0.75
Macro F1	0.72	**0.76**	**0.74**	0.70	0.88	0.60	0.63	0.72	0.73	0.79	0.64	0.74	0.98	1	0.66	0.66	0.84	0.75
Coverage	36	**43**	**44**	32	30	39	44	42	40	31	47	36	16	19	40	52	38	34
Obj. Coverage	53	**60**	**61**	49	47	56	61	59	57	48	64	53	33	36	57	69	55	51

N = 42 positive comments, 42 negative comments, 16 neutral comments

Table 25. Comparison of sentiment detection software by polarity in Spanish comments

	OPINIONLEXICON	SENTISTRENGTH	SOCAL	HAPPINESSINDEX	SANN	EMOTICONSDS	SENTIMENT140	STANFORD	AFINN	MPQA	NRCHASHTAG	EMOLEX	EMOTICONS	PANAST	SASA	SENTIWORDNET	VADER	UMIGON
False Negative	3	**12**	8	3	5	0	44	42	4	5	56	3	0	0	17	13	**2**	**9**
False Positive	17	**12**	21	31	16	50	15	4	19	9	3	27	0	1	13	26	**11**	**6**
False Neutrals	25	**12**	18	17	50	2	0	16	14	38	4	17	69	69	26	3	**29**	**25**
Positive Precision	0.74	**0.80**	0.7	0.61	0.75	0.49	0.76	0.92	0.72	0.84	0.94	0.64	1	0.98	0.79	0.65	**0.81**	**0.89**
Positive Recall	0.94	**0.80**	0.85	0.94	0.90	1	0.52	0.53	0.92	0.90	0.46	0.94	1	1	0.74	0.79	**0.96**	**0.84**
Negative Precision	0.88	**0.65**	0.74	0.88	0.82	1	0.34	0.35	0.85	0.82	0.29	0.88	1	1	0.57	0.63	**0.92**	**0.71**
Negative Recall	0.57	**0.65**	0.52	0.42	0.58	0.31	0.60	0.85	0.54	0.71	0.88	0.46	1	0.95	0.63	0.46	**0.67**	**0.79**
F1 Negative	0.69	**0.65**	0.61	0.57	0.68	0.47	0.43	0.5	0.66	0.76	0.43	0.60	1	0.97	0.60	0.54	**0.77**	**0.75**
F1 Positive	0.83	**0.80**	0.77	0.74	0.82	0.66	0.62	0.68	0.80	0.87	0.62	0.76	1	0.98	0.76	0.71	**0.88**	**0.86**
Macro F1	0.76	**0.73**	0.69	0.65	0.75	0.57	0.53	0.59	0.73	0.82	0.53	0.68	1	0.98	0.68	0.62	**0.83**	**0.81**
Coverage	55	**64**	53	49	29	48	41	38	63	48	37	53	31	30	44	58	**58**	**60**
Obj. Coverage	70	**79**	68	64	44	63	56	53	78	63	52	68	46	45	59	73	**73**	**75**

N= 49 positive comments, 23 negative comments, 28 neutral comments.

In the case of English, over 40 wrong classifications, below .60 in the measures and under 40 in coverage were considered poor scores; while in Spanish, over 30 wrong classifications, below .65 in the measures and under 50 in coverage were considered poor scores. Overall, software tools that performed better were based in human scores. However, the only tool with good performance in both languages was SentiStrength, so it was chosen to be calibrated and employed for sentiment polarity tests. The scores might look low, but if they are compared with results by Araujo et al. (2016), SentiStrength had lower MacroF-1 and higher Coverage in both languages for these text samples, which was considered a better balance for the present study. The SentiStrength software tool includes the following dictionaries:

- Dictionaries with Valence:
    - BoosterWordList: contains superlative and mitigating words like "very" and "might".
    - EmoticonLookupTable: contains emoticons like ":)"
    - EmotionLookupTable: contains any word that implies emotion, like "ache".
    - IdiomLookupTable: contains idioms like "what's up".
- Dictionaries without Valence:
    - EnglishWordList
    - NegatingWordList
    - QuestionWords
    - SlangLookupTable

In the case of SentiStrength in English, over two thousand sentiment words and word stems were obtained from the Linguistic Inquiry and Word Count (LIWC) program (Pennebaker et al., 2003) and the General Inquirer list of sentiment terms (Stone et al., 1966). In the case of Spanish, the dictionaries were based on a valence lexicon (Warriner et al., 2013; García & Thelwall, 2013) translated with Google and stemmed, giving a total result of 8201 lemmas. Other modifications to the dictionaries were based on testing with a wide range of texts by the original developer and several other contributors.

15.3.2 Calibration of SentiStrength

For the present study, several test-based modifications adjusted SentiStrength dictionaries to the context of sustainable design. Regarding graphical symbols, an exploration of the semantic network graphs and a revision of comments informed a reclassification with inclusion of sentiment polarity, shown in Figures 31 to 33. Sentiment for graphical symbols other than emojis in Figures 32 and 33 is marked as pink for negative polarity, yellow for neutral and green for positive polarity.

Figure 31. Adjusted graphical symbols according to sentiment in SDEN (emojis)

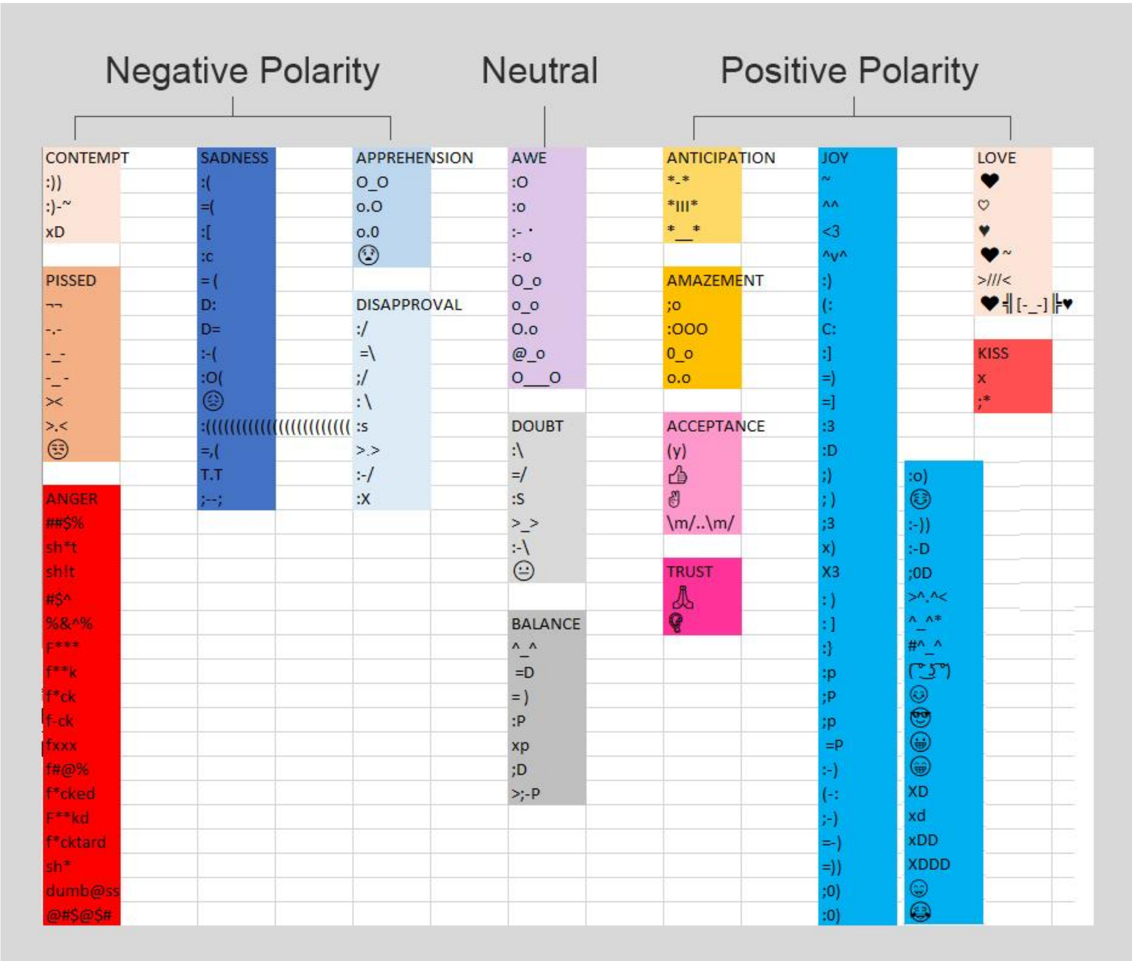


Figure 32. Adjusted graphical symbols according to sentiment in SDEN (others)

AROUSAL
!
!@!!!
¡
>:O
f*ckin

COMMUN	MEANING
+	gplus
@	reply
@	at
#	hash

CALCULAT	MEANING
%	percent
=	equal
=/=	not equal
+	plus
-	to
-	minus
x	by
>	better/gre
<	less than
^	exponent
#	number
°	degrees
*	grades
*	by

MONEY
$
§
~$
S
£
€

OBJECTS	MEANING
*	asterisc
*****	stars
~	tilde
Ψ	hell
▲	fire
◢	triangle
◣	triangle
ڲجڲ ♥ ڲجڲ	name

DIRECTION
--

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^
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>>
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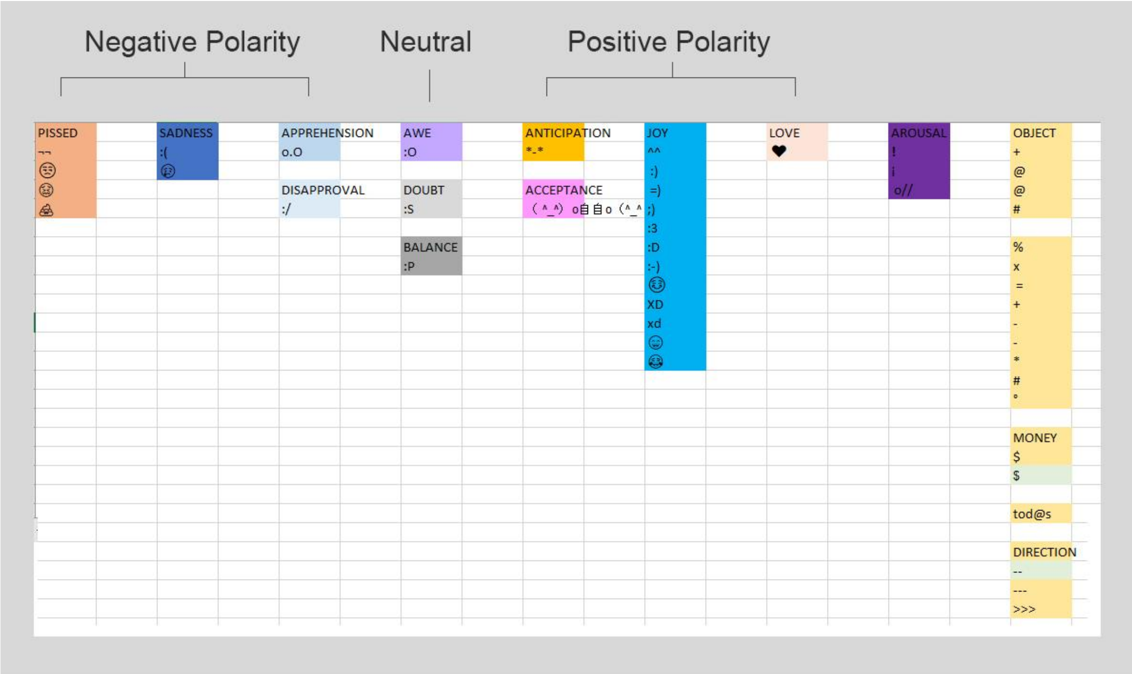
LIVING BE	MEANING
	palm
	flower
	dove

Figure 33. Adjusted graphical symbols according to sentiment in SDES



A revision on false positives, negatives and neutrals in the sentiment benchmark test revealed several words that should be added to the dictionaries. This list was complemented with the A-lists for both languages, and a few derivatives and synonyms of the terms. Also, an increase on the sensibility to negativity in English and to positivity in Spanish were considered, which was translated as addition of words with a polarity according to the expected sensibility increase. In some cases, sentiment scores of words included in the SentiStrength dictionaries by default were modified.

Table 26 shows summarized results of English calibration applied in the samples of 100 comments. Most of the added words had a negative polarity. Nevertheless, the addition of graphical symbols did not aid emotion classification in this case.

Table 26. Calibration of SentiStrength in English

Measure	Sample without modifications	Sample with graphical symbols substitution					
		Additional words	Additional words	Additional words	Additional words	Additional words	**More additional words**
				All Graph. Symbols	Graphical Symbols (+)	Graphical Symbols (-)	**Graph. Symb. (-)**
- F1	0.76	**0.78**	0.78	0.77	0.77	0.78	**0.78**
+ F1	0.76	**0.78**	0.78	0.77	0.77	0.78	**0.78**
M-F1	0.76	**0.78**	0.78	0.77	0.77	0.78	**0.78**
Coverage	43	**49**	48	48	48	48	**49**
Obj. Cov.	61	**67**	66	66	66	66	**67**

Spanish users sometimes wrote without accents and letters like “ñ”, due to lack of education and the difficulty of changing the language in electronic devices. Therefore, some of the calibration tests included adding terms with incorrect orthography to the dictionaries. Default dictionaries were developed and optimized for Spain’s Spanish (also called Castilian), but not for Latin American Spanish. Thus, many verbal conjunction forms had to be added.

Table 27 shows summarized results of Spanish calibration tests. Most of the additional words were positive and the inclusion of graphical symbols aided emotion classification in terms of M-F1 and coverage. The best results were obtained by also adding misspelled words with positive polarity to the dictionary.

Table 27. Calibration of SentiStrength in Spanish

Measure	Sample without modifications			Sample with graphical symbols substitution						
		Additional words	Additional words	Additional words	Additional words	Additional words	Additional words	Additional words	Additional words	**More addl. words**
			Mispelled words		Mispelled words		Mispelled words			**Misp. words (+)**
						All Graph. Symb.	All Graph. Symb.	Graph. Symbols (+)	Graph. Symbols (-)	**Graph. Symbols (+)**
-F1	0.65	0.67	0.66	0.68	0.67	0.68	0.67	0.68	0.68	**0.69**
+ F1	0.80	0.81	0.80	0.82	0.81	0.82	0.81	0.82	0.82	**0.83**
M-F1	0.73	0.74	0.73	0.75	0.74	0.75	0.74	0.75	0.75	**0.76**
Coverage	64	72	72	72	72	72	72	73	71	**74**
Obj. Cov.	85	93	93	93	93	93	93	94	92	**95**

15.3.3 Sentiment Analysis by Category

Because of the role specific negative emotions might be playing in relationship with pro-environmental behaviours, this study also considered a sentiment ana-lysis by type of emotion. The Syuzhet library for R (R Core Team, 2013) classifies words simultaneously in ten emotion categories: anger, anticipation, disgust, fear, joy, sadness, surprise, trust, positive and negative. This library was based on Mohammad and Turney's (2013) NRC Emotion lexicon, which was crowdsourced and is available in several languages. The first eight emotions in the lexicon correspond to the medium ring of Plutchik's emotional wheel (1980).

Because the sentiment polarity detection software was already adjusted to the comments context, only the first eight scores calculated with Syuzhet were considered. Comments without modifications were uploaded to R to perform the analysis. As there were some seasonality peaks in YouTube video posting found in the first chapter, the sentiments were plotted through time to find their seasonality peaks.

Plutchick's theory of emotions is based on identification through facial expressions, which might not be reliable for emotion classification through text (Bann, 2012). Therefore, ten comments per sentiment and in some cases combinations of sentiments were selected at random for qualitative analysis on their content. Moreover, procedures to estimate and compare relationships between sentiment categories in the two languages were conducted based on Epskamp & Fried (2018), and Fried et al. (2018). In concrete:

1.Relationships between sentiments were calculated through Spearman correlation, analysed through a modularity test to find clusters and drawn with Gephi software.

2.Networks were estimated and visualized through polychoric correlations and joint graphical lasso penalization (see Danaher et al., 2014); and sentiment predictability (also called shared variance) was estimated taking on account nearby emotions in R.

3. Sentiment scores means were correlated with their standard deviations.

4. Sentiment scores means in the two languages were correlated with each other.

If these procedures result in similar estimations, there can be more confidence in their reliability, besides showing how different are the sentiments related to sustainable design in the two languages.

15.4 Statistical Analysis

A Spearman Correlation was conducted to evaluate how congruent the two sentiment polarity and eight sentiment category scores were before proceeding with testing relationships between words and sentiments. The results can be found in Annexes 23 and 24.

Words in the two A-lists were considered for a network modularity test to detect word clusters. The top 14 clusters in terms of the sum of word frequencies in each language were chosen for correlation analysis. The threshold for clusters in

English was 4,000 of word frequency and in the case of Spanish, it was 400, considering that the comments database was roughly 1 tenth the size of SDEN. Some of the word clusters contained graphical symbols. Samples of the clusters' content for both languages can be consulted in Annexes 25 and 26.

Correlations between sentiment scores and word clusters were conducted in SPSS. According to the results, multiple rank regression analysis was performed to find out how much a word cluster (hence a topic) could predict sentiment.

16. RESULTS

16.1 SDEN Comments

16.1.1. Descriptive Statistics of SDEN Comments

Descriptive statistics shown in Figures 34 to 36 were obtained with R. The month when more comments were posted in Top English videos was March, while Sunday, Monday and Tuesday were the preferred days for posting. People commented more in the afternoon and night, with a peak around 6 p.m., and a day cycle starting at 7 a.m.

Figure 34. SDEN Number of Comments in Top Videos per Month (N=13976)

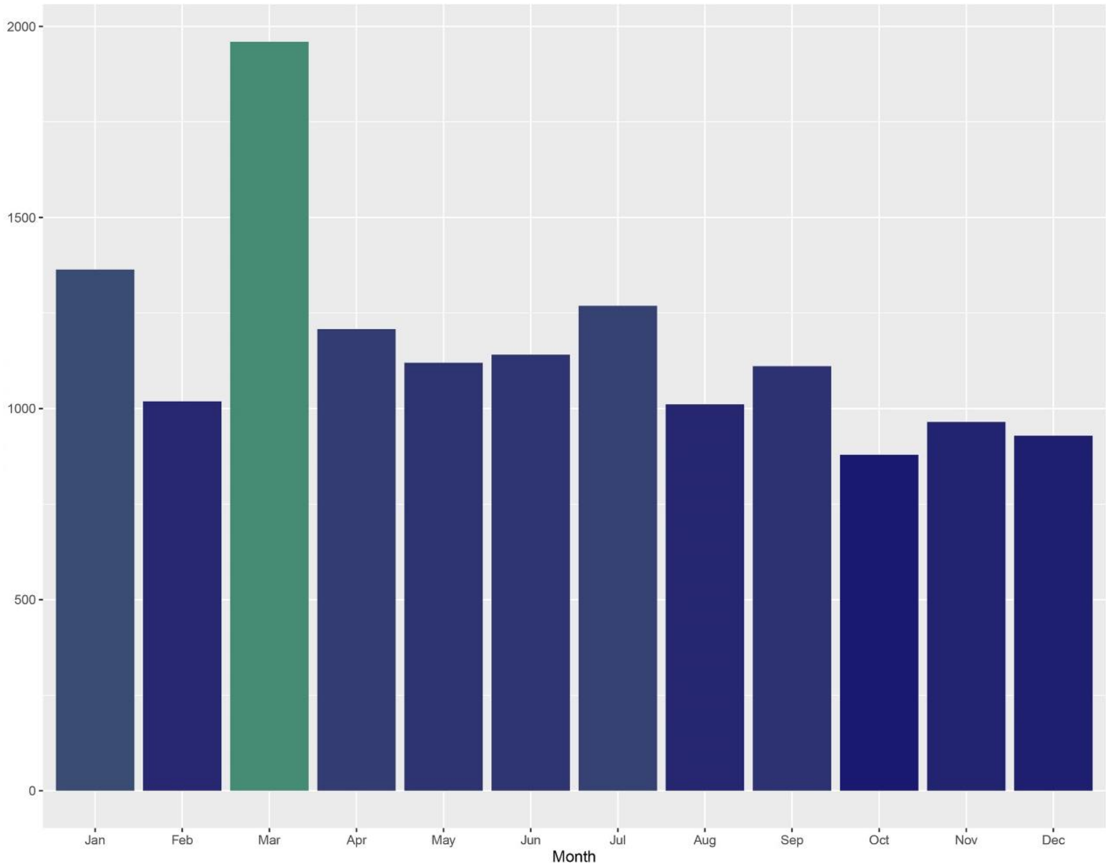


Figure 35. SDEN Number of Comments in Top Videos per Day of the Week (N=13976)

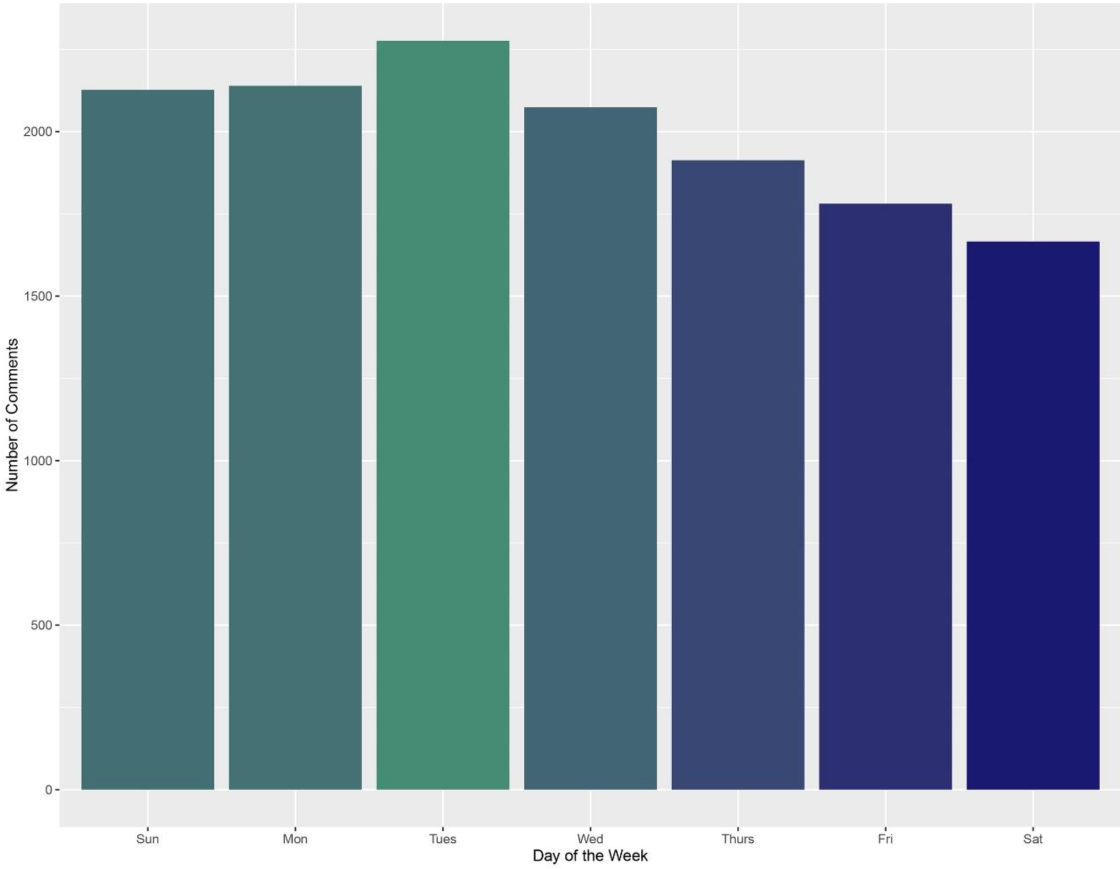
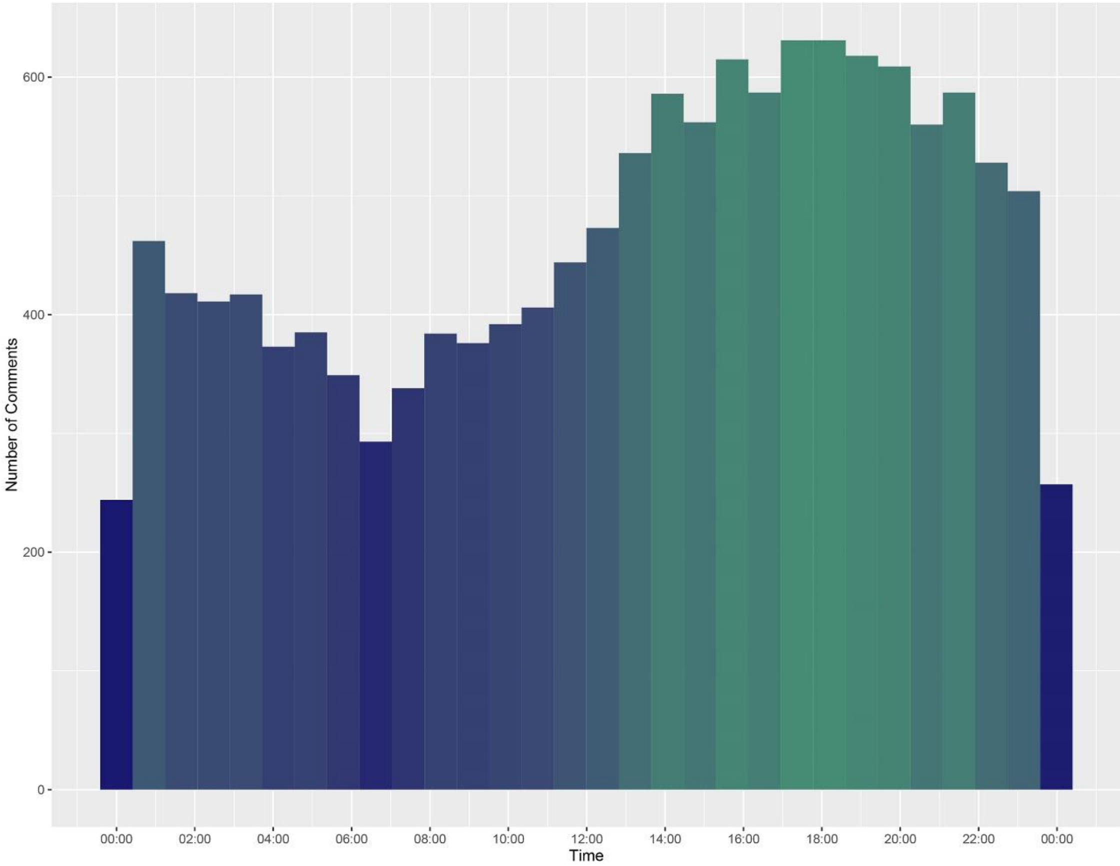


Figure 36. SDEN Number of Comments in Top Videos per Hour (N=13976)



16.1.2. Topic Modelling in SDEN Comments

Table 28 lists the Top 20 topics from a total of 70 calculated with Latent Dirichlet Allocation (LDA). They have been divided in four sets. A few graphical symbols were included among the first set of topics (words that begin with “gs”). The type of design featured in the topics is related to cities and energy, while several male individuals were mentioned. The second set deals with psychological aspects of humans that are perceived as barriers for sustainable design, while the third one is composed by conversations between YouTube users (hence the presence of user names, anonymized with asterisks). Lastly, the fourth set deals with technology and its impact on humans.

Table 28. SDEN Top 20 topics based on LDA (N=13976)

Topic	Weight	Words
Main topics		
1	1.1116	gsexc (!), gsplus (+), dont, make, system, year, city, problem, human, house
2	1.0653	people, world, gsat (@), video, power, resource, free, made, cost, doesnt
3	0.9598	energy, great, idea, life, love, guy, gspercent (%), talk, understand, back
4	0.9311	live, time, gsgrin, technology, government, idea, good, lot, bad, food
5	0.8793	man, solar, society, jacquefresco, fact, part, project, reason, stop, oil
6	0.8780	good, start, put, making, real, U.S.A., environment, wont, things, fuel
7	0.8215	work, place, elonmusk, nice, companies, long, economy, stuff, produce, genius
8	0.8046	future, design, water, car, run, change, building, cool, pretty, issue
9	0.6885	isnt, create, mind, person, light, require, lead, clean, follow, funny
10	0.6647	money, read, mind, urban, fair, mankind, walk, taught, approach, context
11	0.6490	men, effect, theory, eventually, quote, speaker, star, viable, method, transportation
Ideologies		
12	0.5578	psychology, cooling, typical, magic, overpopulation, individuality, psychological, stored, faith, visual
13	0.4698	comfy, incorporated, lightning, pathetic, illusion, intend, license, understandable, simpleton, christianity
Arguments and Conversations		
14	0.4646	admit, loss, arent, adolescent, claimed, seaside, shots, entrepreneur, deserts, exciting
15	0.4280	draker*****, scape, back, refining, breakthroughs, indefinitely, energies, dated, transportation, bi*****
16	0.4095	evidence, electronics, ban, president, describes, ing, restore, platform, capital, security
17	0.3853	create, packs, critically, url, buy, skyscrapers, jaguar, hvdc, tragedy, notable
18	0.3700	techna*****, properties, youre, excited, slower, fascism, asia, idiot, adobe, starbucks
Technology		
19	0.3693	hearing, equator, imagined, moot, mechanics, framework, joining, performed, development, inviting

20	0.3686	robot, spill, frustrating, myths, hut, magic, germans, behavioral, disadvantages, ownership

16.1.3. Word Frequency in SDEN Comments

Figure 37 shows percentages of word categories found in A-List. The most frequent categories were Kansei (219 words, 36%), direct objects (143 words, 23%) and verbs (117 words, 19%), which suggests more descriptive than action-oriented comments. Among verbs, 58 (9%) were in infinitive form, 32 (5%) were connectors, 16 (3%) were in past form and 11 (2%) were continuous, which also suggests more conceptualization and future oriented comments than present oriented.

Figure 37. Distribution of Word Categories in SDEN A-list (N=613)

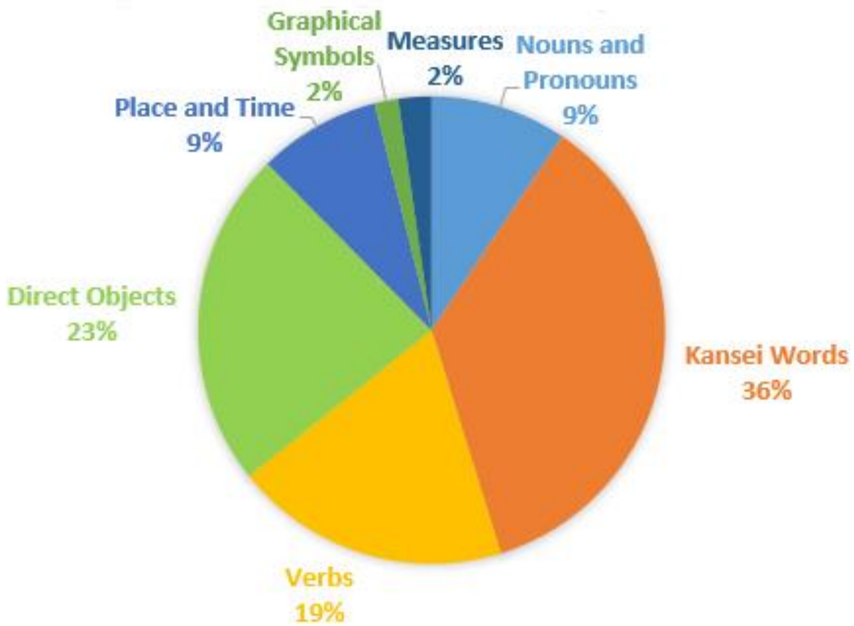


Table 29 shows samples of the four lists generated with Top most frequent words. Pronouns (contained in category 1) and a few graphical symbols (category 6) were among the most used words, while cognitive words were among the most frequent in Kansei (category 2).

Table 29. Samples of SDEN word lists (N=13976)

A-List				**Negative List**			
Word	**Frequency**	**Cat.**	**Subcategory**	**Word**	**Frequency**	**Cat.**	**Subcategory**
you	8880	1	Pronoun	you	8880	1	pronoun
i	8872	1	Pronoun	i	8872	1	pronoun
gsexc1 (!)	4769	6	Symbol	gsexc1 (!)	4769	6	symbol
not	3964	2	Negation	not	3964	2	negation
have	3890	3	Connector	have	3890	3	connector
we	3742	1	Pronoun	we	3742	1	pronoun
people	2944	1	Noun	people	2944	1	noun
they	2837	1	Pronoun	they	2837	1	pronoun
will	2802	3	Connector	will	2802	3	connector
he	2733	1	Pronoun	he	2733	1	pronoun
236 List				**246 List**			
Word	**Frequency**	**Cat.**	**Subcategory**	**Word**	**Frequency**	**Cat.**	**Subcategory**
not	3964	2	Negation	not	3964	2	negation
like	2423	2	Cognitive	like	2423	2	cognitive
no	1927	2	Negation	no	1927	2	negation
need	1414	2	Cognitive	need	1414	2	cognitive
don't	1392	2	Negation	don't	1392	2	negation
think	1324	2	Cognitive	think	1324	2	cognitive
because	1277	2	Cognitive	because	1277	2	cognitive
know	1160	2	Cognitive	know	1160	2	cognitive
idea	1107	2	General	idea	1107	2	general
want	1044	2	Cognitive	want	1044	2	cognitive

No bigrams became a single word because their frequency was small, as it can be appreciated in Table 30. It was also noted that top bigrams included several positive expressions:

Table 30. Top bigrams in SDEN

First Word	Second Word	Frequency
thank	You	262
I	agree	194
in	world	172

don't	Know	168
like	You	165
solar	panel	163
of	course	135
in	U.S.A.	121
for	All	116
for	people	114

16.1.4. Semantic Network of SDEN Comments

Figure 38 represents a directed semantic network for the A-list of most frequent words in the dataset, which includes 613 terms organized through the Force Atlas algorithm. Node size corresponds to word frequency and tie thickness to the words' relationship strength. In this network, several terms describe culture and science; while the words *system*, *technology*, *energy* and the verb *change* are together, close to the centre of the network. It thus can be inferred that system thinking is frequently present in the comments. Moreover, words like *feel*, *care* and *matter* are connected to *life*, *information*, *future* and space science related words.

Figure 38. Semantic Network of SDEN A-list
(N=613, Node size = 8880 to 75, Tie thickness = 6459 to 1).

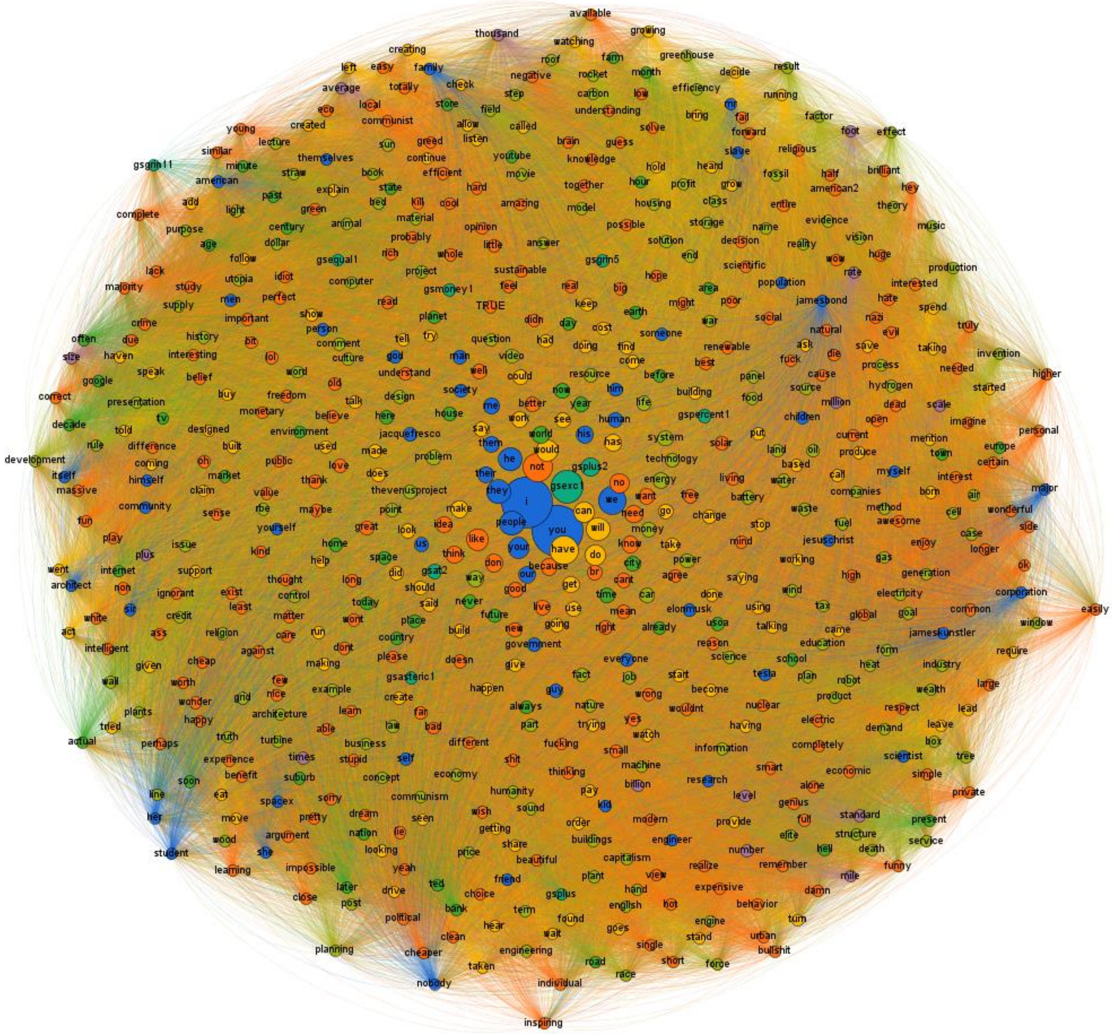
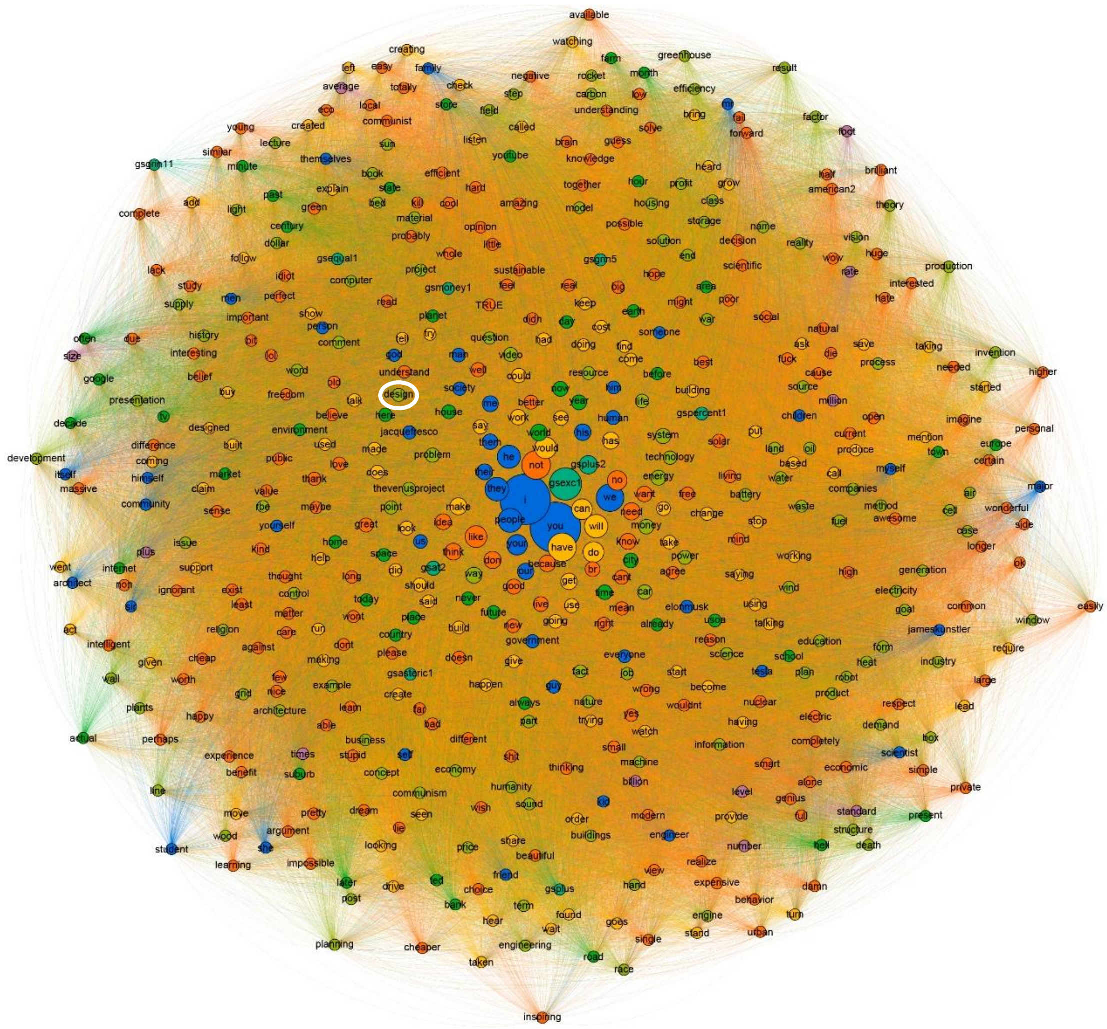


Figure 39 shows words connected to *design* (located close to the centre, towards the North West). Although there are both positive and negative descriptive terms, design is linked to *intelligent*, *smart*, and other cognitive words; while terms related to aesthetics like *beautiful* are not so relevant.

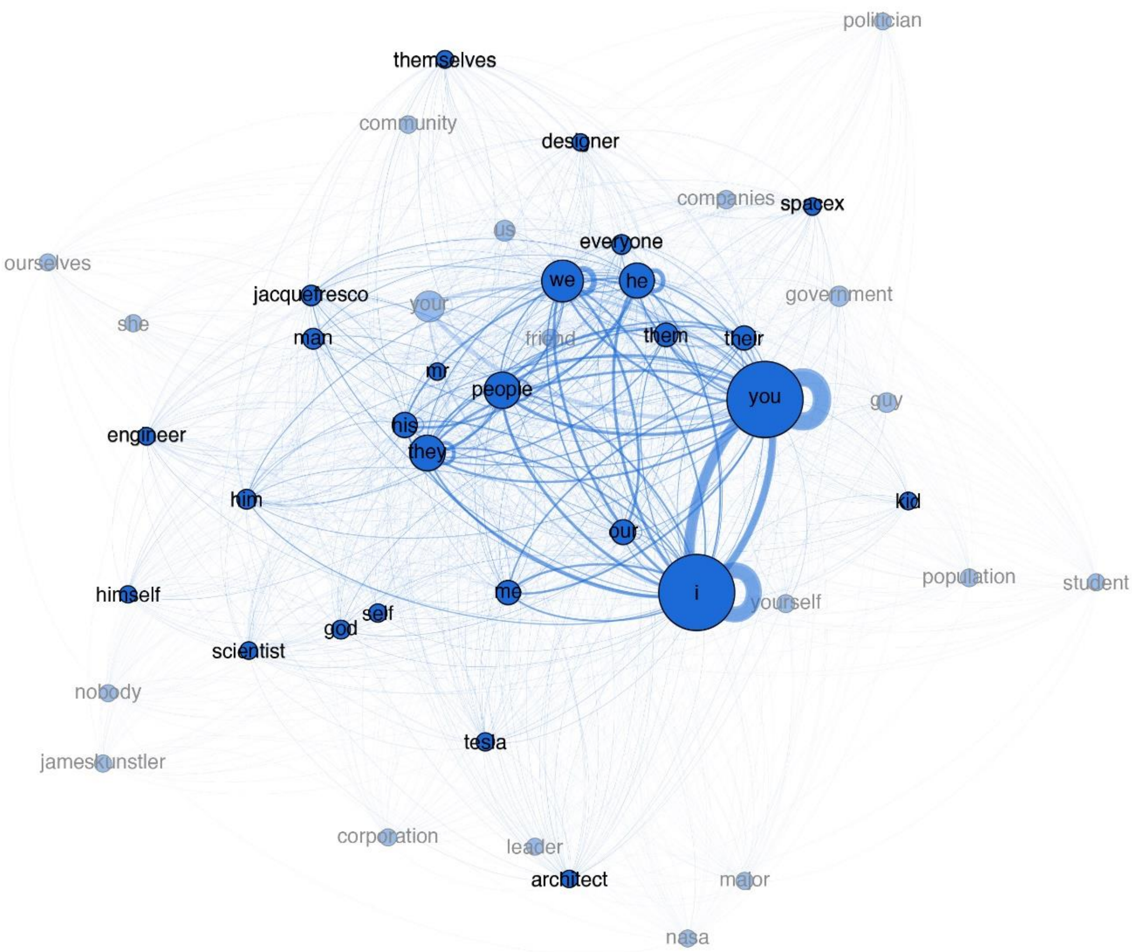
Figure 39. Words connected to Design in SDEN A-list Semantic Network



It is also important to mention the relationship between living beings in this network. Several nouns and pronouns located in the centre are among the most frequent words, being *I* and *you* the biggest nodes. The relationship between these words was also strong (1,944 times forth and 1,331 times back), suggesting frequent conversations between users.

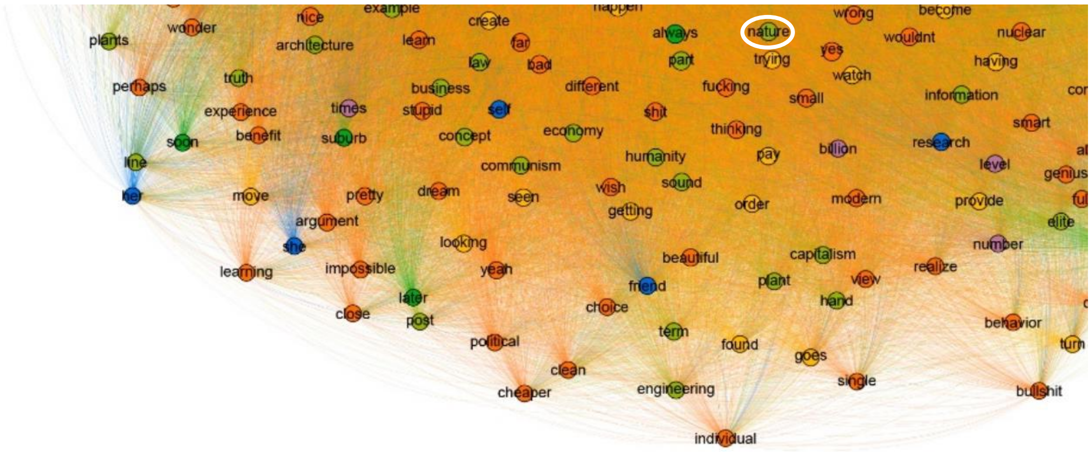
If only nouns and pronouns are visualized, relationships between designers and other stakeholders can be highlighted. Figure 40 shows that architects (located in the bottom) were mentioned in comments related to a wide range of stakeholders, including the government, companies, students and leaders. Meanwhile, the word *designer* (located in the upper area) had a more limited range of stakeholders.

Figure 40. Intersection of stakeholder relationships for *architect* and *designer* in SDEN A-list network



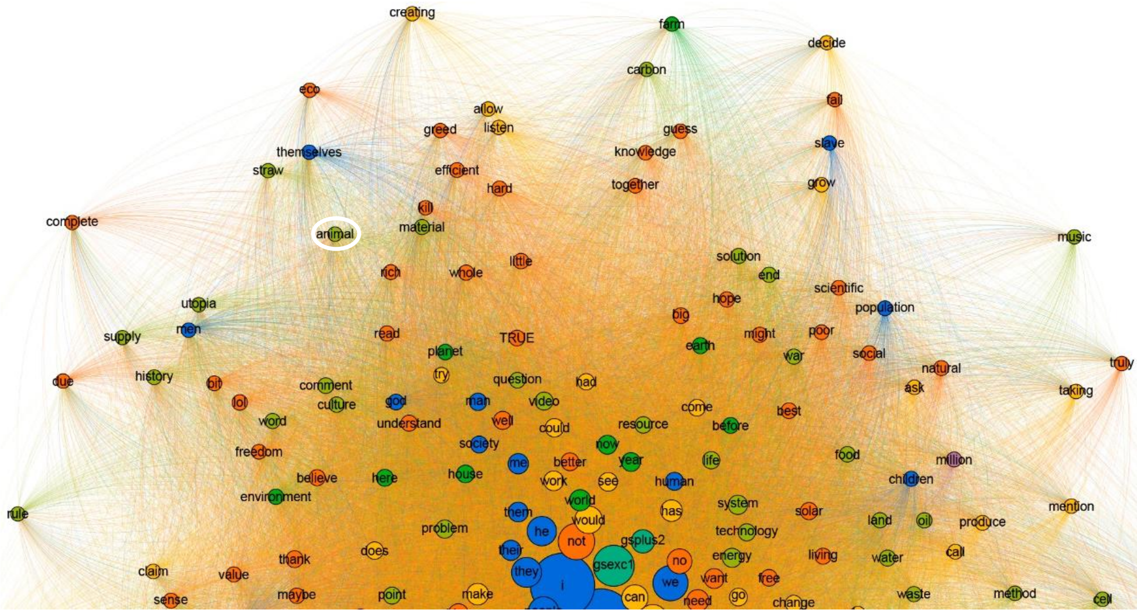
Although non-human beings were less mentioned, relationships between nature and female pronouns could be appreciated (Figure 41). This confirms the view of nature as female documented in the literature review.

Figure 41. Sample of words connected to *nature* in SDEN A-list Semantic Network



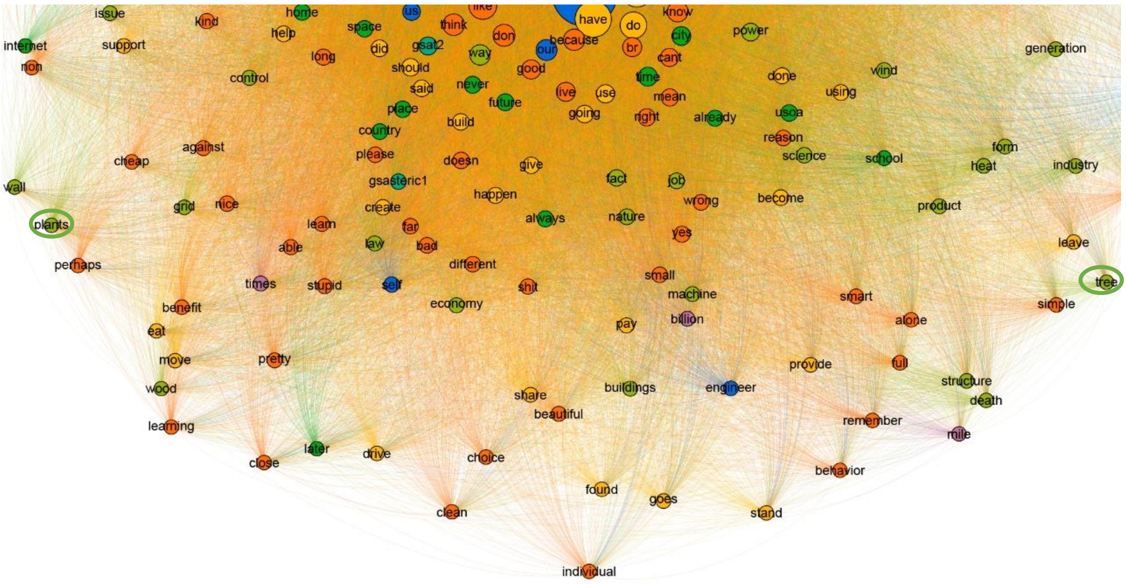
Words connected to *animal* (e.g. *kill, materials, understand*) suggest an awareness of their lives, a need to understand them, but also the fact that we kill them and a view of them as raw materials, as can be appreciated in Figure 42.

Figure 42. Sample of words connected to *animal* in SDEN A-list Semantic Network



As for plants and trees, they were connected to the environment (living planet) in general but also to the designed environment (e.g. structure, product, home), as shown in Figure 43. Plants were linked to the verb *eat* as well. Overall, such relationships with the environment and other living beings suggest an expanded view of the design process and those who are affected by it.

Figure 43. Sample of words connected to *plants* in SDEN A-list Semantic Network. The word *tree* is on the opposite side, almost at the same height.



A directed graph for the Negative List was also drawn and explored. The graph included 601 words organized through the Force Atlas algorithm. Node size corresponds to word frequency and tie thickness to the words' relationship strength. As can be appreciated in Figure 44, emotions like hate, fear and sadness were connected to a variety of people related words, suggesting that negative emotions (and thus psychological barriers to adopt sustainable design) are linked to people and society. Moreover, some comments reflected difficulty to accept different societal orders. Few negative emotions were connected to *planet/world*, with the exception of sadness. This might indicate ecophilia, the appreciation of living beings and their systemic relationships with their environments.

Figure 44. Negative List of SDEN Semantic Network
(N=613, Node size = 8880 to 49, Tie thickness =6459 to 1).

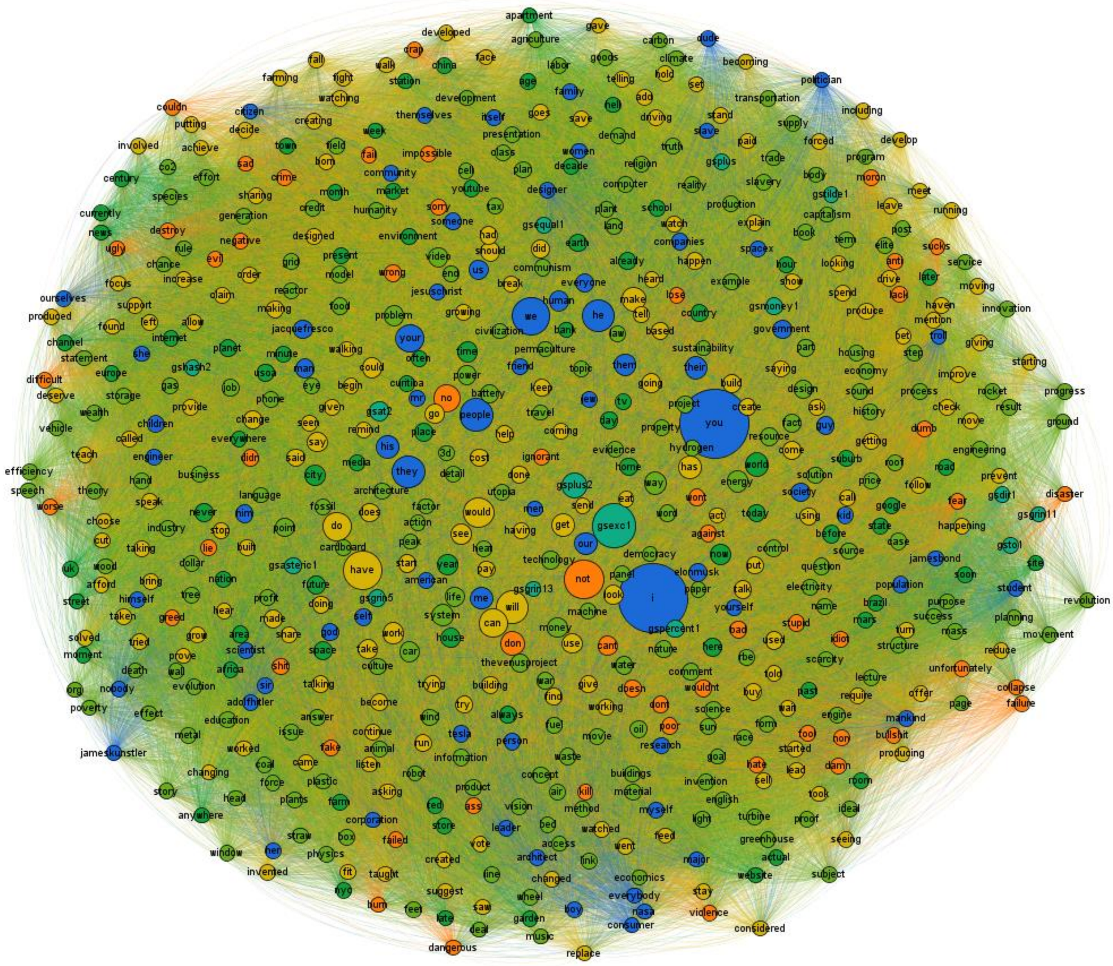
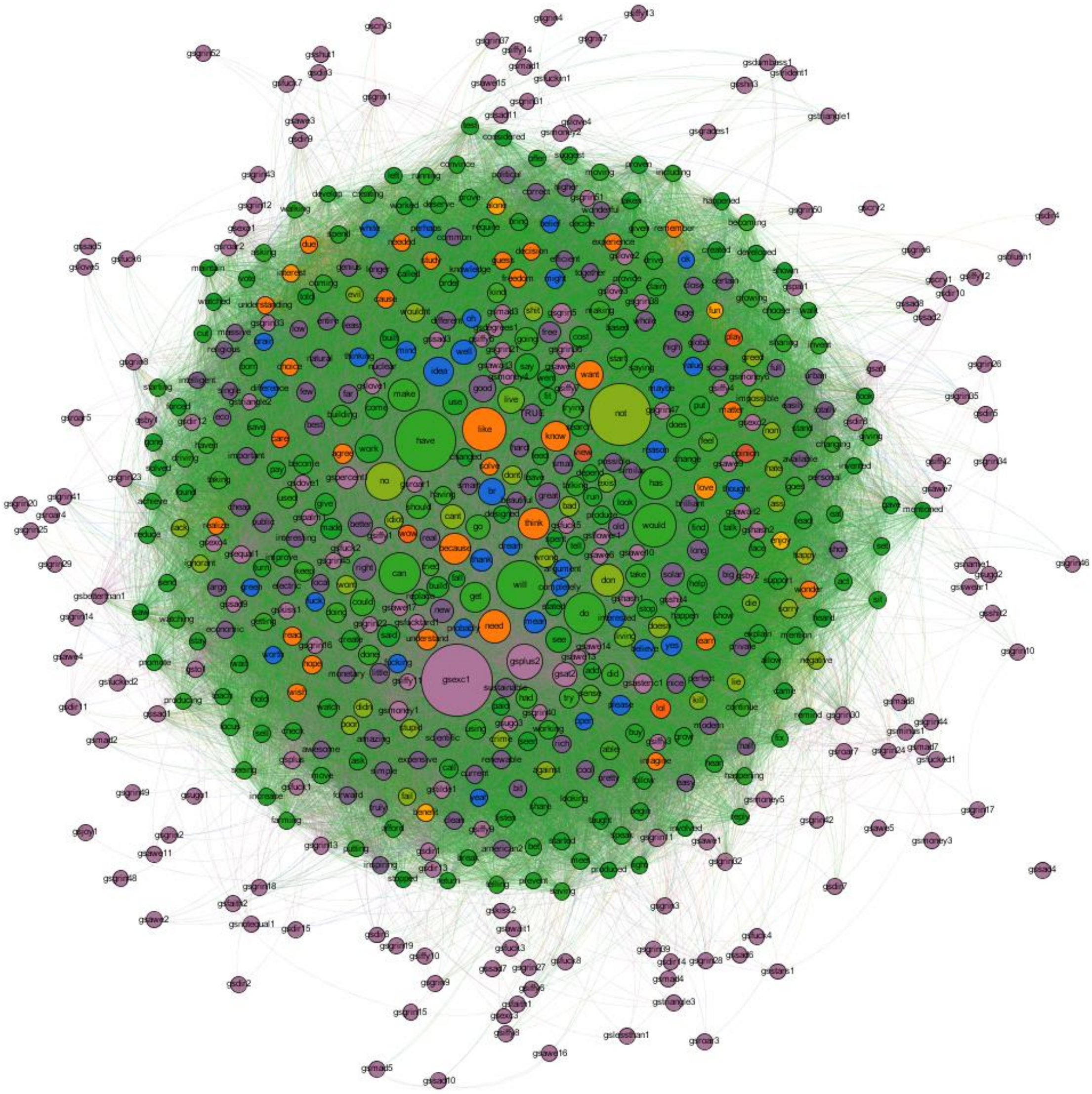


Figure 45 represents the directed graph for the 236 List, which included 601 words organized through the Force Atlas algorithm. Node size corresponds to word frequency and tie thickness to the words' relationship strength. This network explores the relationship between Kansei words, behaviours and graphical symbols. Several symbols which were used only a few times are represented as a disperse outer ring, surrounding more frequent words.

Figure. 45 Semantic Network of SDEN 236 List
(N=601, Node size = 4769 to 1, Tie thickness =6459 to 1).

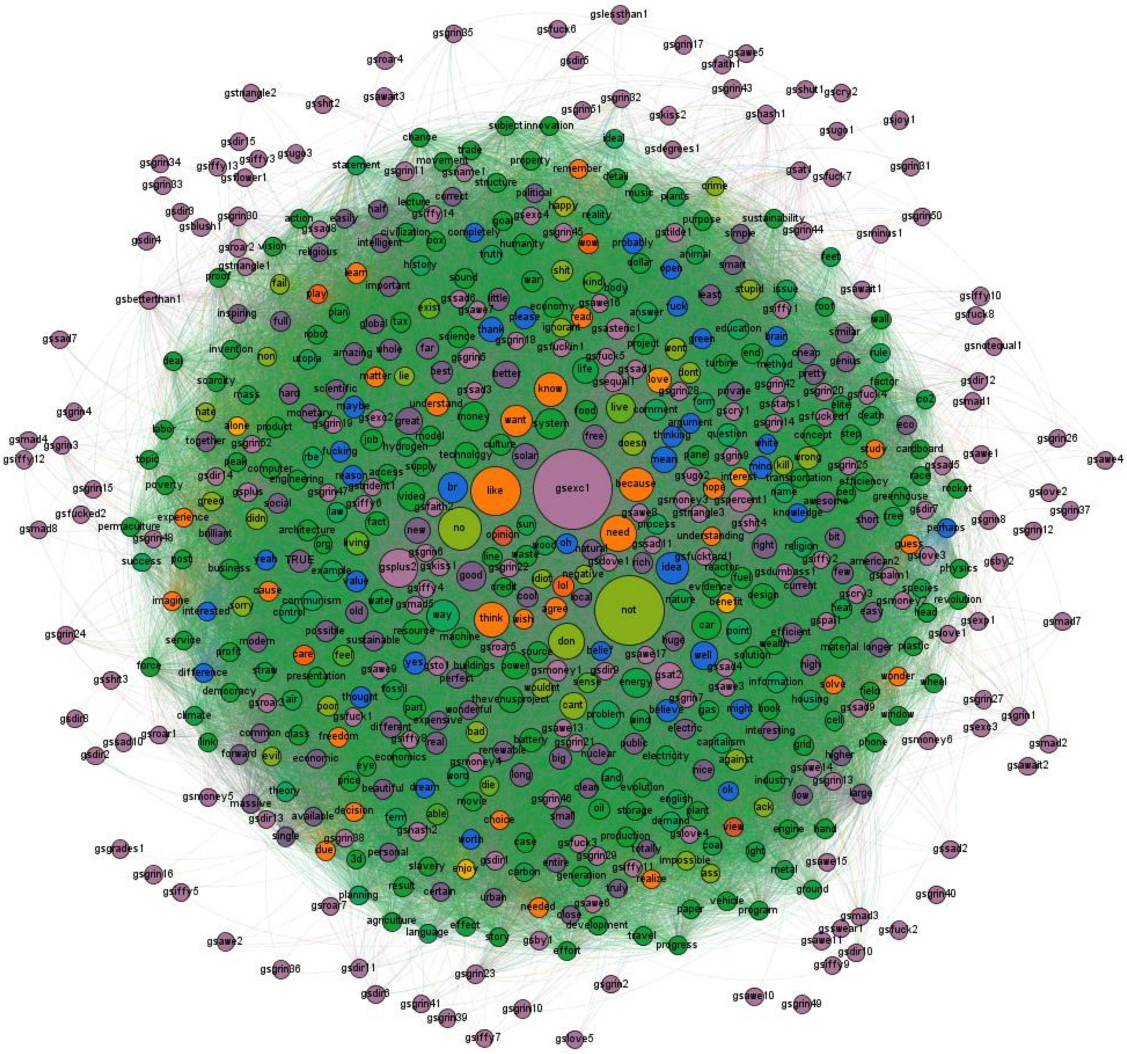


The word *natural* was connected to *life* and other positive terms. While *build* and *designed* were linked to both positive and negative words and graphical symbols, *create* and *created* were mostly connected with positive terms. Other cognitive words like *learn* and *solve* were not related to graphical symbols, which might imply they are used in more objective scenarios, while the term *teach* was linked to both positive and negative words. The word *care* was not related to graphical symbols representing faces, but was linked to money, suggesting a more materialistic view of care.

Figure 46 represents a directed graph for the 246 List, which includes 600 words organized through the Force Atlas algorithm. Node size corresponds to word frequency and tie thickness to the words' relationship strength. This network explores the relationship between Kansei words, direct objects and graphical symbols. Several symbols that were scarcely used appear as a ring surrounding more frequent words in this visualization too.

Figure 46. Semantic Network of SDEN 246 List

(N=600, Node size = 4769 to 1, Tie thickness =6459 to 1).

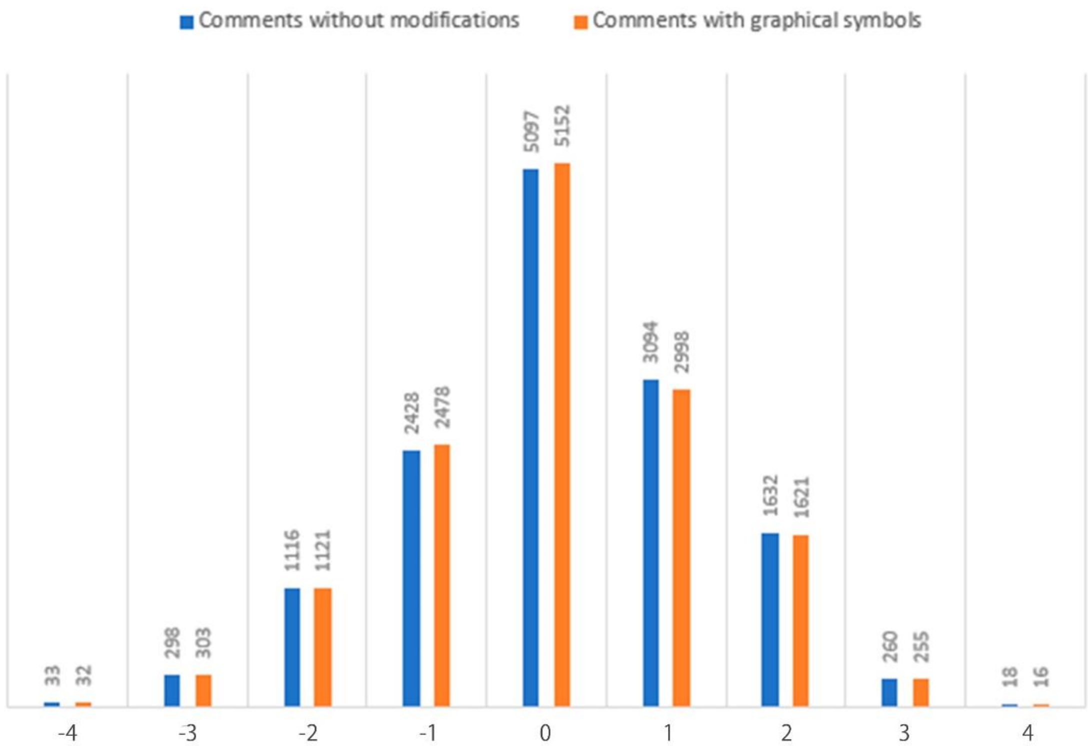


Materials like cardboard and plastic were connected to graphical symbols re-presenting smiles. Also, the term *music* was linked to graphical symbols suggesting positive emotions, which might indicate that music affected the videos favourably. The term *beautiful* was connected to *expensive* and to several graphical symbols that suggested positive but also ambiguous emotions (e.g. >.>). Ambivalent and ambiguous emotions were linked to materials like coal, oil and carbon, while metal was related to ambivalent terms. The word *education* was connected to ambivalent terms but to *plants* and *animal* as well, suggesting a broader scope of education for designers. In contrast, the word *scarcity* and other terms related to economy were less connected to graphical symbols, suggesting more objectivity in conversations involving such term.

16.1.5. Sentiment Polarity of SDEN Comments

Figure 47 shows English comments according to their SentiStrength scores. The X axis corresponds to the score and the y axis to number of comments. The score reflects the sum of the two polarities (positive and negative), where zero means neutral. The average polarities were (*1.8889, -1.7800*) for the sample without modifications and (*1.8772, -1.7830*) for the sample with alphanumerical graphical symbols. Thus, as expected since the software calibration process, addition of graphical symbols did not affect the sentiment scores considerably, only making them slightly more neutral.

Figure 47. Sentiment Polarity in SDEN (N= 13976)



Most comments (5097, 36.46%) were neutral in the sample without modifications, followed by 5004 (35.80%) comments with positive polarity, and 3875 (27.72%) comments with negative polarity. This implies that, although most comments did not show a dominant polarity, the overall sentiment of the texts was slightly positive, as reflected in the average polarity sum (0.1090). An Emotionality score for each video was also calculated using the following formula:

$$e = (np*-1) + pp - 2$$

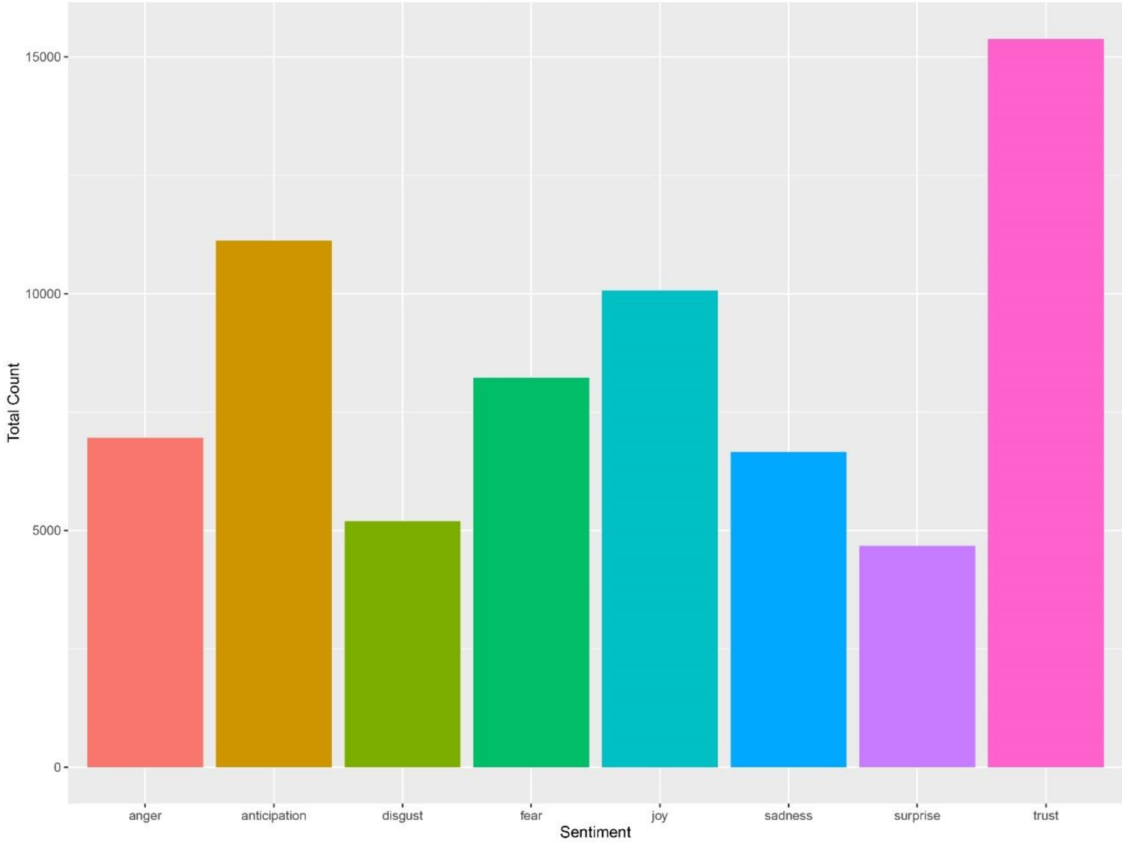
Where *e* represents emotionality, *np* negative polarity and *pp* positive polarity. The average was 3.66 in terms of Emotionality for SDEN comments.

A qualitative analysis in random comments with maximum positive polarity (5,-1) found that such messages tend to be short and clear, focused in the video, the speaker and the design object. On the other hand, maximum negative messages tended to be long and had orthographical errors. They also had a tendency for rationality and criticism of the design object. Racism towards people was found as well. Next, the average polarities (1.8889, -1.7800) were rounded to (2,-2) for another qualitative analysis. Such comments tended to be long and rational, while criticism towards design and some rejection of people was found.

16.1.6. Sentiment Categories of SDEN Comments

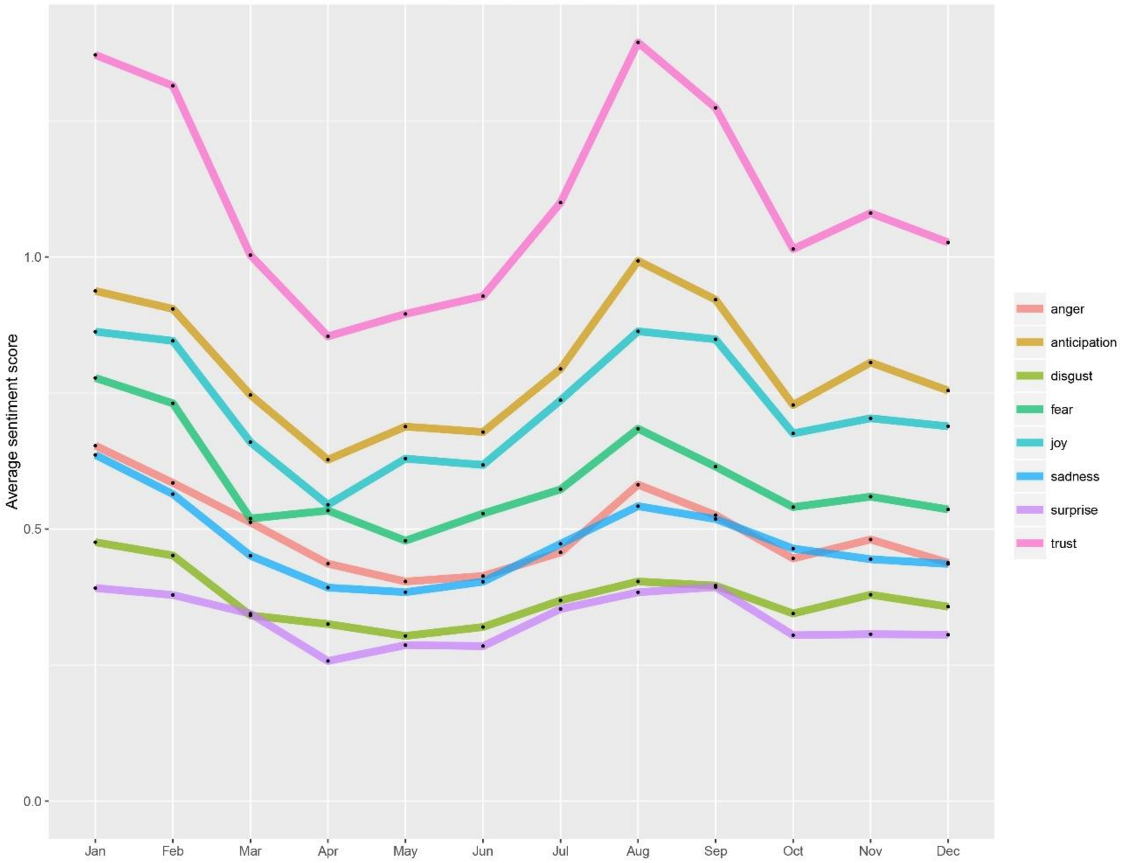
Figure 48 shows the scores in axis Y, while axis X corresponds to the eight basic emotions according to Plutchick. The score is bigger than the total number of comments because some comments contained words with a value higher than one, and also because the comments tended to be long. It can be noted that Trust was the emotion with a higher score, followed by Anticipation, Joy, Fear, Anger, Sadness, Disgust and Surprise.

Figure 48. Sentiment Scores by Category in SDEN (N= 13976)



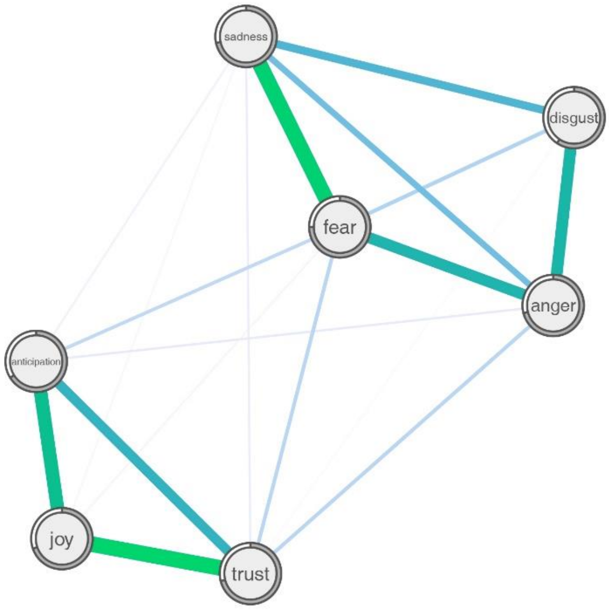
Because videos posting tended to be seasonal, Figure 49 was drawn to detect emotional peaks across time. The X axis shows the months while the Y axis represents average sentiment scores. It can be noted that the highest emotional peaks were in January, February and August, while emotions mostly declined in April, May and June. Popular videos about The Venus Project, Curitiba (a Brazilian city), Elon Musk and James Kunstler were posted in the first months of the year. However, sentiment peaks do not correspond with videos posting volume shown in Figure 16. Moreover, sentiment peaks do not correspond with comments post volume across time shown in Figure 33. This might indicate that only some comments concentrated in a few popular videos are highly emotional, which coincides with the high number of comments valued as neutral by SentiStrength.

Figure 49. Sentiment by Category per Month in SDEN (N= 13976)



Surprise was found to be unreliable when a random sample of comments was crosschecked with the scores, so it was not taken on account for further analysis. The network based on Spearman correlations coincided with the network estimation in R (see Annex 27). Figure 50 shows a network graph, where each node re-presents a sentiment, the ring around the node represents sentiment predictability and tie thickness reflects polychoric correlation. Two clusters were distinguishable, corresponding to positive and negative emotions bridged mostly by Anticipation and Fear. This link could also be representing a transition between the moderate versions of these emotions according to the Plutchik (1980) wheel, interest and apprehension.

Figure 50. SDEN Sentiment Network per Categories



Other relevant bridges between positive and negative emotions were between Trust and Fear, and Trust and Anger, which could be representing acceptance, apprehension and annoyance. Nevertheless, the strongest tie was between Joy and Trust, which could be suggesting love. Unique features of this network were the strong relationships between Fear and Sadness, and Anger and Sadness. Node predictability was overall good, particularly in the case of Fear.

A qualitative analysis in ten top comments in terms of sentiment category scores was summarized in Table 31. Joy tended towards serenity and was mixed with negativity, while role models referred to in the texts were male. It is noted that Anger and Sadness were elicited for the same reasons in the sample comments, suggesting also according to the sentiment network estimation, that racism is a relevant component on the comments. However, some top comments were so similar that they might have been posted by bots or users with an agenda.

Table 31. Summary of Qualitative Analysis on Top SDEN Comments in Terms of Sentiment Category Scores

Trust	Anticipation
• Long arguments that talk to the user directly about a wide range of topics.	• Interest on sustainable design. • Vigilance towards money, politics, society, technology.

Fear	Anger and Sadness
• Ineffective design. • Losing autonomy. • Losing freedom. • Not changing. • People.	• Racism. • System.
Disgust	
• Ignorance • Money • Politics • Religion • People • Society • War	

An analysis of random ten comments with average scores in the most common emotion (Trust), revealed that the texts were linked to sustainable design and actors involved with it, which highlight the human dimension of this practice. Ten comments with a value of 1 in Anticipation, Anger, Sadness and Disgust, and ten comments with a value of 1 and 2 in Fear were analysed as well. The summary can be consulted in Table 32. It was noted that the only sentiment directly related to nature was fear, concretely to natural disasters. In the case of anger, it was mostly linked to energy topics, and sadness was connected to love for both people and design objects. The relationship between ineffectiveness and ugliness should also be noted in comments expressing disgust.

Table 32. Summary of Qualitative Analysis on Isolated Sentiment Category Scores in SDEN Comments

Anticipation	Joy
• Interest for sustainable design methods and role models. • Vigilance towards information, society.	• Sustainable design is cheap. • Role models are modest.
Fear	**Anger**
• Government. • Ignorance. • Inefficient design.	• Batteries and energy. • Inefficiency. • Lack of enough information.

• Lack of enough information. • Losing freedom. • Natural disasters. • Not changing.	
Sadness	**Disgust**
• Connected to love for design and people. • Unfeasibility of sustainable design.	• Ineffective and ugly sustainable design. • Lack of enough information. • People.

Because Anger and Sadness had close scores across time and they shared a strong link in the network estimation, a qualitative analysis on 10 random comments with simultaneous scores of 1 in Anger and Sadness was conducted. These texts showed disagreements between YouTube users. In the case of 10 random comments with simultaneous scores of 1 in Fear and Sadness, they expressed apprehension, discussing improvements to products but accepting sustainable design.

16.1.7. Correlation and Regression Analysis in SDEN Comments

Results of Non-Parametric Correlations between top 14 word clusters, sentiment polarity scores and seven sentiment category scores are shown in Table 33. Results marked in dark green are correlations while those marked in light green are slight correlations. Word clusters were more correlated with negative sentiments, with the exception of cluster 4 *She*. Clusters with strong multiple correlations were cluster 5 *People* and 9 *American*, which are topics mainly about humans. Clusters 7 *He* and 8 *Design* were the least correlated to emotions, which suggests that topics about engineering and design were more objective. As for the cluster more related to the living planet and non-human beings (6 *Holistic*), it was correlated with both positive and negative emotions.

Table 33. Spearman Correlation between Word Clusters and Sentiment Scores in SDEN

	1 James	2 Ignorance	3 Energy	4 She	5 People	6 Holistic	7 He	8 Design	9 American	10 Sci-Tech	11 Information	12 Money	13 Jacque	14 System
Positive	.193**	.151**	.063**	.411**	.248**	.147**	.135**	.146**	.133**	.145**	.145**	.123**	.118**	.129**
Negative	-.283**	-.325**	-.251**	-.027**	-.332**	-.269**	-.158**	-.164**	-.330**	-.292**	-.277**	-.252**	-.253**	-.279**
Anger	.255**	.291**	.248**	.042**	.313**	.276**	.173**	.147**	.340**	.305**	.303**	.351**	.249**	.287**
Anticipation	.310**	.291**	.281**	.107**	.343**	.333**	.209**	.229**	.320**	.322**	.306**	.344**	.264**	.327**
Disgust	.234**	.254**	.198**	.053**	.266**	.228**	.132**	.155**	.279**	.233**	.228**	.230**	.208**	.224**
Fear	.261**	.289**	.213**	.067**	.329**	.306**	.181**	.154**	.340**	.303**	.281**	.266**	.278**	.334**
Joy	.268**	.255**	.239**	.156**	.321**	.307**	.179**	.224**	.282**	.284**	.265**	.345**	.233**	.267**
Sadness	.268**	.285**	.230**	.049**	.323**	.284**	.129**	.178**	.329**	.286**	.274**	.267**	.250**	.275**
Trust	.336**	.338**	.289**	.094**	.382**	.365**	.227**	.269**	.356**	.364**	.358**	.378**	.307**	.376**
**P<0.01, N=13976														

For regression analysis, scores superior to 0.15 in terms of Adjusted R Square were considered good predictors of sentiments. As can be appreciated in Table 34, the words that were better sentiment predictors were related to people and the economic system (clusters 5 *People*, 12 *Money*, 9 *American* and 14 *System*). Meanwhile, energy, engineering and design related clusters (cluster 3 *Energy*, 8 *Design* and 7 *He*) scored the lowest, suggesting more objectivity in these topics. It also should be noted that words related to the living planet and non-human beings (cluster 6 *Holistic*) had a significant level of sentiment prediction ($F(9,1341)=343.372$, $p<0.005$, $R^2=.181$).

Table 34. Rank Regressions on SDEN Word Clusters

Dependent Variable	F	R Square	Adjusted R Square
5 People	459.389	0.228	0.228
12 Money	400.369	0.205	0.205
9 American	397.567	0.204	0.203
14 System	372.83	0.194	0.193
10 Science-Technology	350.388	0.184	0.184
6 Holistic	343.372	0.181	0.181
2 Ignorance	332.252	0.176	0.176
11 Information	327.32	0.174	0.174
4 She	323.556	0.173	0.172
1 James	310.23	0.167	0.166
13 Jacque	240.613	0.134	0.134
3 Energy	225.672	0.127	0.126
8 Design	151.152	0.089	0.088
7 He	122.799	0.073	0.073
Independent variables: Positive Polarity, Negative Polarity, Anger, Anticipation, Disgust, Fear, Joy, Sadness, Trust.			
Regression = 9, Residual = 13966, P<0.005			

16.2. SDES Comments

16.2.1. Descriptive Statistics of SDES Comments

Descriptive statistics shown in Figures 51 to 53 were also obtained with R. The month when more comments were posted in Top Spanish videos was July, while Monday and Tuesday were the preferred days for posting. These week days coincide with the English data set. The pattern of hours where people commented more frequently also roughly matched SDEN, covering afternoon and night. However, the day started earlier (at 6 a.m.) and peaked earlier too (at 4 p.m.). This might be due to the hour disparity between most of Latin American countries and Spain, which had the higher number of localized videos in the sample.

Figure 51. SDES Number of Comments in Top Videos per Month (N=1351)

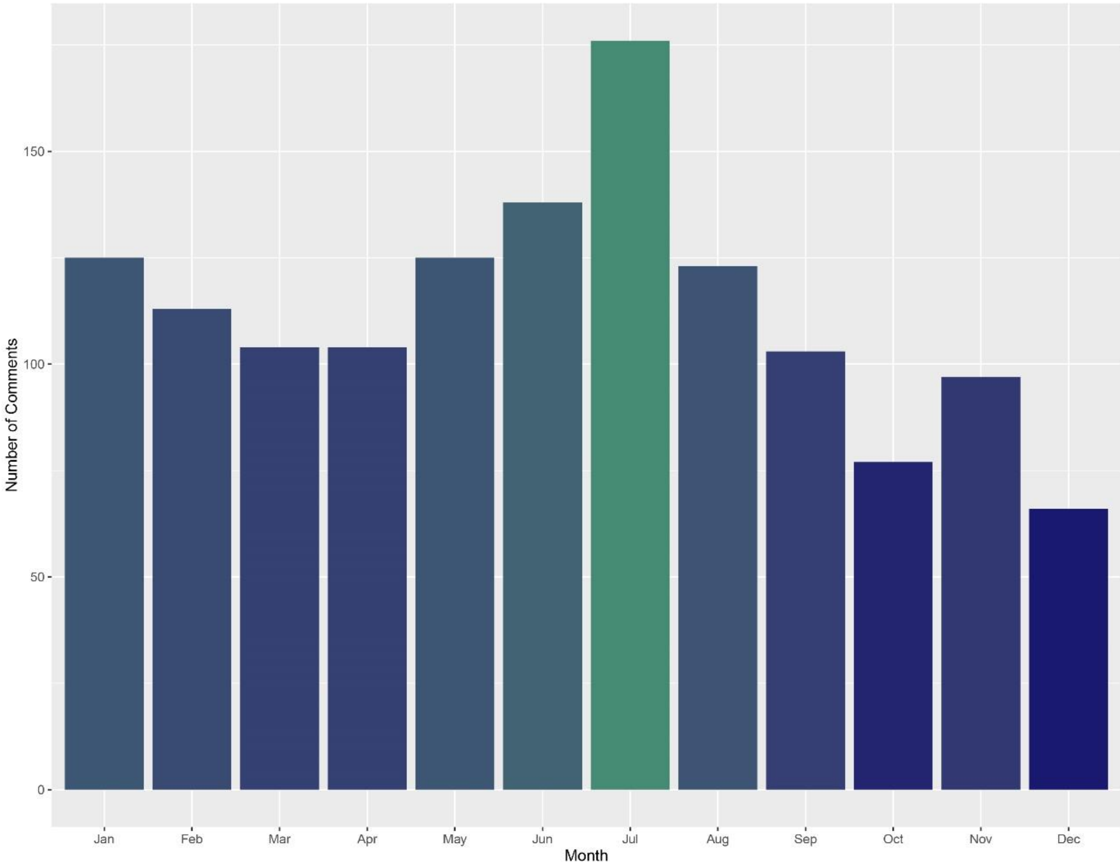


Figure 52. SDES Number of Comments in Top Videos per Day of the Week (N=1351)

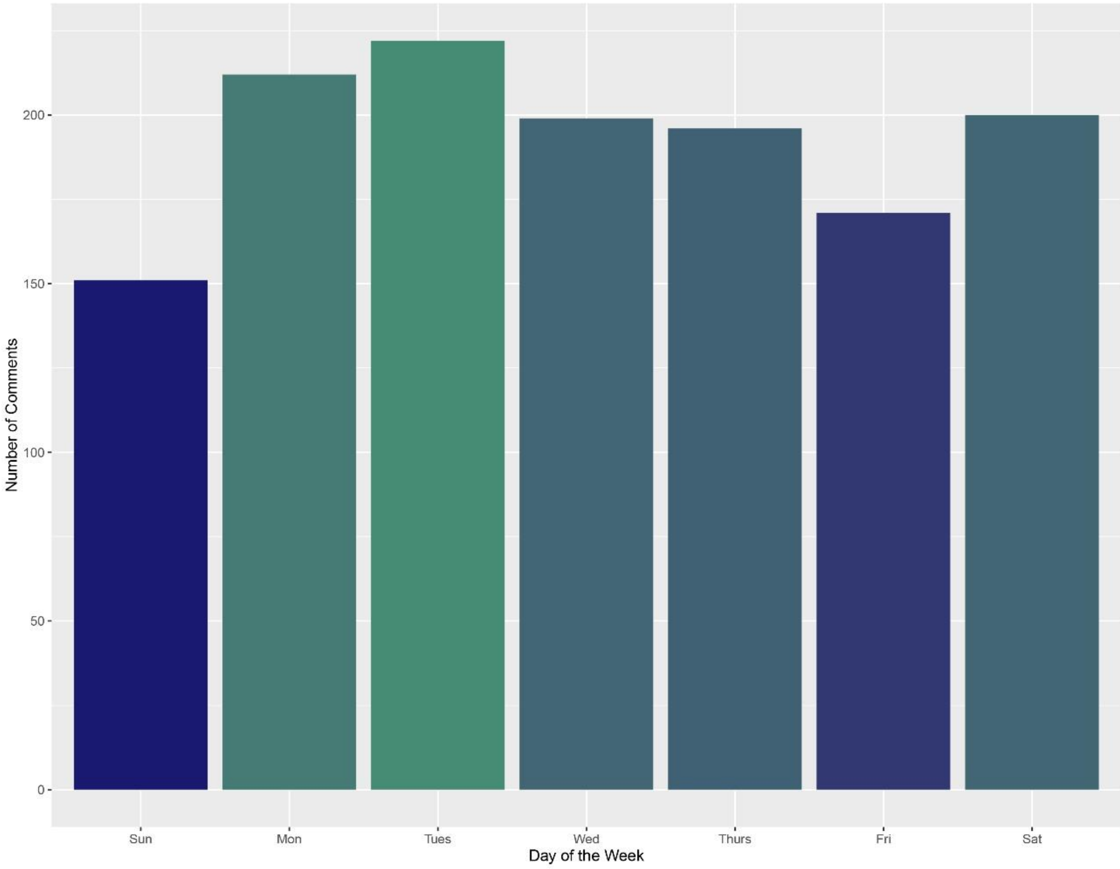
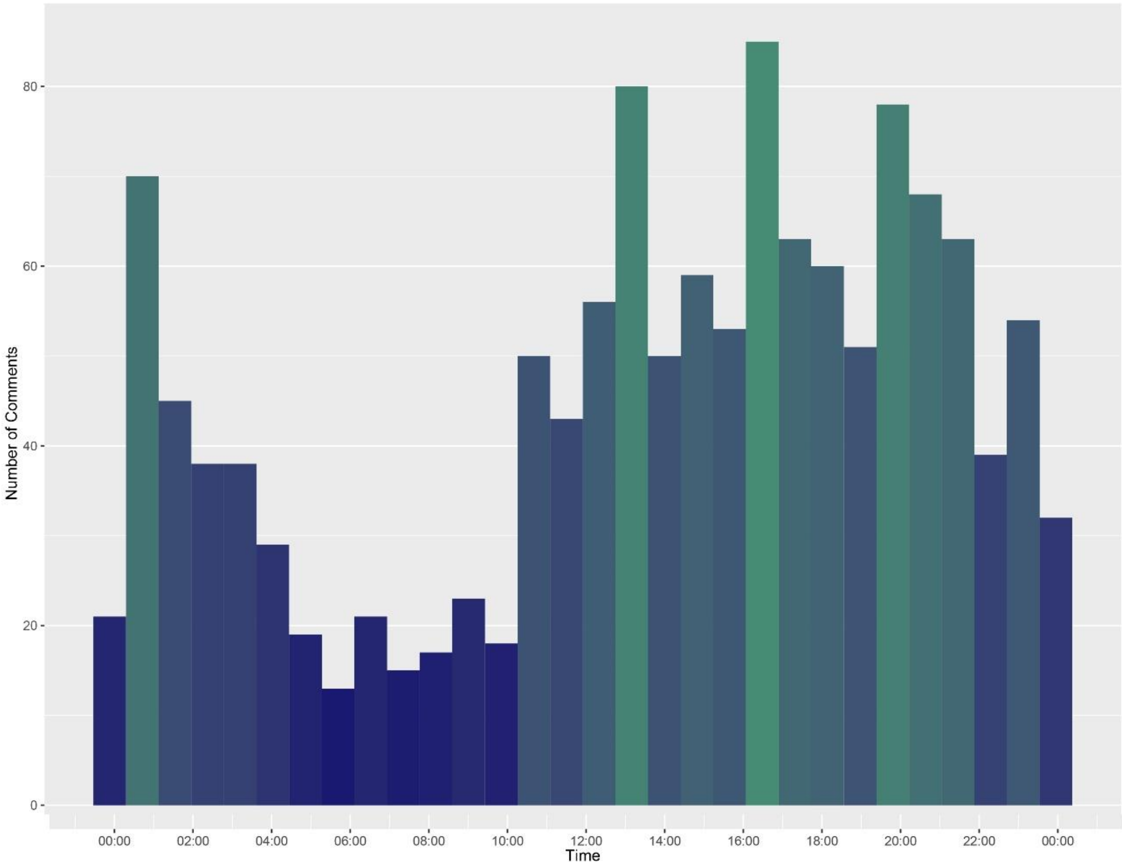


Figure 53. SDES Number of Comments in Top Videos per Hour (N=1351)



16.2.2. Topic Modelling in SDES Comments

Table 35 lists the Top 20 topics from a total of 70 calculated through Latent Dirichlet Allocation (LDA). They have been divided in 5 rough sets. The symbol (*!*) was included among the first set of topics, which comprises several location names. The second set dealt with architecture and featured several YouTube user names, while the third one included a few design objects like cars, furniture and kitchens. The fourth set was related to society and politics, while the last set mentioned construction techniques, materials, locations and designers. It is noted that the type of design featured in the topics is related to specific projects.

Table 35. SDES Top 20 topics based on LDA (N=1351)

Topic	Weight	Words
Main Topics		
1	18.3560	que, gsexc (!), para, por, una, las, gracias, mas, https, del
2	11.8349	los, con, como, muy, esta, www, casa, hola, saludo, bueno
3	1.1900	mcarmonago*****, parque, hacemos, asi, crezca, almohadilla, asiento, pocos, leyva, recipiente
4	0.9725	encuentra, quienes, buen, elmanzano, responsabilidad, construiste, atrapasuenios, presente, compatible, recomendable
5	0.9456	algunas, estaremos, condiciones, conectar, sos, vertical, corto, caso, novedad, terapiaurbana
Architecture		
6	0.9189	sustrato, manga, nosotros, simulador, trabajan, formaleta, alojamiento, utilizo, perdona, necesitarian
7	0.9109	hablar, diaria, realizar, parque, tope, vuelvo, aproximadamente, mukta*****, tendre, precisamente
8	0.9053	conocer, tecnologico, banio, altruista, agosto, explicando, cuentan, daniino, camino, bioarquitectura
9	0.9037	industrial, segundo, principalmente, pagar, carmendel*****, encuentres, contexto, aplicarlos, propuesta, pasto
10	0.8937	linoantoniorosasji*****, llegar, descripcion, queria, maderplast, recorded, linobeltranpo*****, puente, vista, separacion
Design Objects		
11	0.8815	contar, capa, duracion, vuestras, provecho, abengoa, cundinamarca, fortalezas, salud, aplicado
12	0.8797	automoviles, cocina, mentira, hacerle, muebles, cielo, gaia, independiente, corriente, agotar
Socio-Politics		
13	0.8744	tantas, compadre, reciclaje, madre, cobrar, algunas, programa, unidades, restaurar, contra
14	0.8726	tenia, gov, local, agradeceria, sse, javier, primeros, realizara, mejorar, pieza
Construction Techniques		
15	0.8716	tela, contacto, contaminan, visitar, historia, segunda, apreciar, fijate, jorgebelanko, supuesto

16	0.8706	pasar, fierro, costarica, suelo, index, generan, gsdir, profesional, sustrato, tardes
17	0.8689	normas, centro, mismo, fierro, mayoria, paoapique, real, entendi, pieza, especial
18	0.8656	asiento, php, carlos, edu, mediante, inteligente, grados, vuelve, espacio, responder
19	0.8650	totalmente, importancia, acuerdo, alberto*****, fueron, sonido, utilizo, eucaliptus, dialogandoconlatierra, pena
20	0.8608	actualmente, introducir, mite, entrevista, volver, documentacion, redondo, cordoba, dando, bambu

16.2.3. Word Frequency in SDES Comments

Figure 54 shows percentages of word categories in A-List. The most frequent categories were direct objects (184 words, 30%), Kansei (157 words, 26%) and verbs (115 words, 19%), which suggests more action-oriented than descriptive comments. Among verbs, 65 (11%) were in infinitive form, 37 (6%) were connectors, 8 (1%) were in past form and 5 (1%) were continuous, which suggests more conceptualization and future oriented comments than present oriented, in similar terms to SDEN.

Figure 54. Distribution of Word Categories in SDES A-list (N=614)

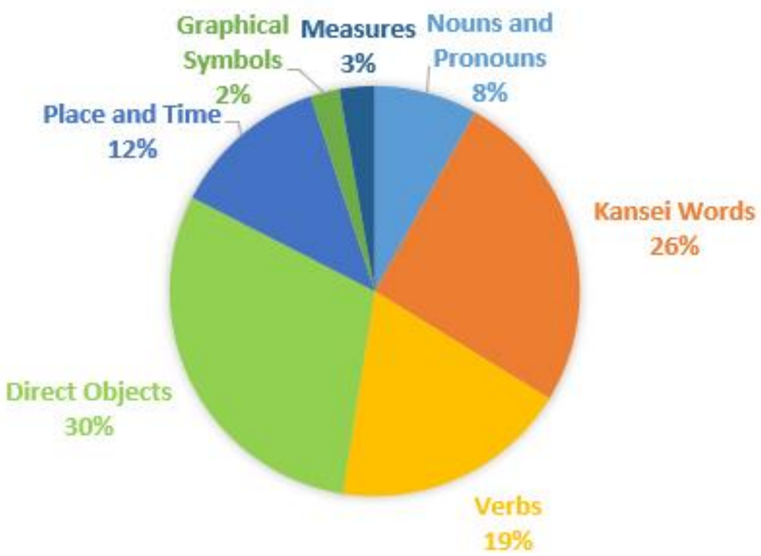


Table 36 shows samples of the four lists generated with Top most frequent words. Their categories were more varied than in SDEN. Kansei words and two graphical symbols (!, +) were among the most frequent terms, while the general subcategory was the most frequent in Kansei (category 2). The presence of a few direct objects should also be noted.

Table 36. Samples of SDES word lists (N=1351)

A-List				**Negative List**			
Word	**Frequency**	**Category**	**Subcategory**	**Word**	**Frequency**	**Category**	**Subcategory**
gsexc1 (!)	706	6	symbol	gsexc1 (!)	706	6	symbol
no	463	2	negation	no	463	2	negation
gracias	258	2	general	puedo	179	3	connector
si	250	2	general	video	166	4	unnatural
puedo	179	3	connector	casa	164	5	place
video	166	4	unnatural	mi	163	1	pronoun
casa	164	5	place	su	161	1	pronoun
mi	163	1	pronoun	youtube	147	5	place
su	161	1	pronoun	saludo	140	4	unnatural
youtube	147	5	place	tiene	131	3	connector
236 List				**246 List**			
Word	**Frequency**	**Category**	**Subcategory**	**Word**	**Frequency**	**Category**	**Subcategory**
gsexc1 (!)	706	6	symbol	gsexc1 (!)	706	6	symbol
no	463	2	negation	no	463	2	negation
gracias	258	2	general	gracias	258	2	general
si	250	2	general	si	250	2	general
puedo	179	3	connector	video	166	4	unnatural
hola	141	2	general	hola	141	2	general
tiene	131	3	connector	saludo	140	4	unnatural
bueno	123	2	adjective	bueno	123	2	adjective
br	121	2	general	br	121	2	general
gsplus2 (+)	118	6	symbol	gsplus2 (+)	118	6	symbol

Bigrams also did not become a single word due to their small quantity, as can be appreciated in Table 37. With the exception of the most frequent bigram (corresponding to an anti-bull fighting campaign) this sample included several positive expressions, just as in SDEN:

Table 37. Top bigrams in SDES

First Word	Second Word	Frequency
contra	barbarie	66
muchas	gracias	50
gracias	!	46
muy	bueno	46
un	saludo	37
muy	interesante	27
saludo	!	25
por	favor	22
en	mexico	21
muy	bien	20

16.2.4. Semantic Network of SDES Comments

Figure 55 represents a directed semantic network for the A-list of most frequent words in the dataset, which includes 614 top frequent terms organized through the Force Atlas algorithm. Node size reflects word frequency, and tie thickness, relationship strength. Several terms are related to communication and design objects. The words *cultura* (culture), *sistema* (system) and *tecnología* (technology) are present as in SDEN, but not *ciencia* (science). Also, terms like *siento* (feel), *interesante* (interesting), and *importa* (matters) are connected to positive words, permaculture, design, change, system and technology. Moreover, the term *necesito* (need) was connected to expertise, norms, (didactic) knowledge and diffusion related words.

Figure 55. Semantic Network of SDES A-list

(N=614, Node size = 706 to 6, Tie thickness = 1166 to 1)

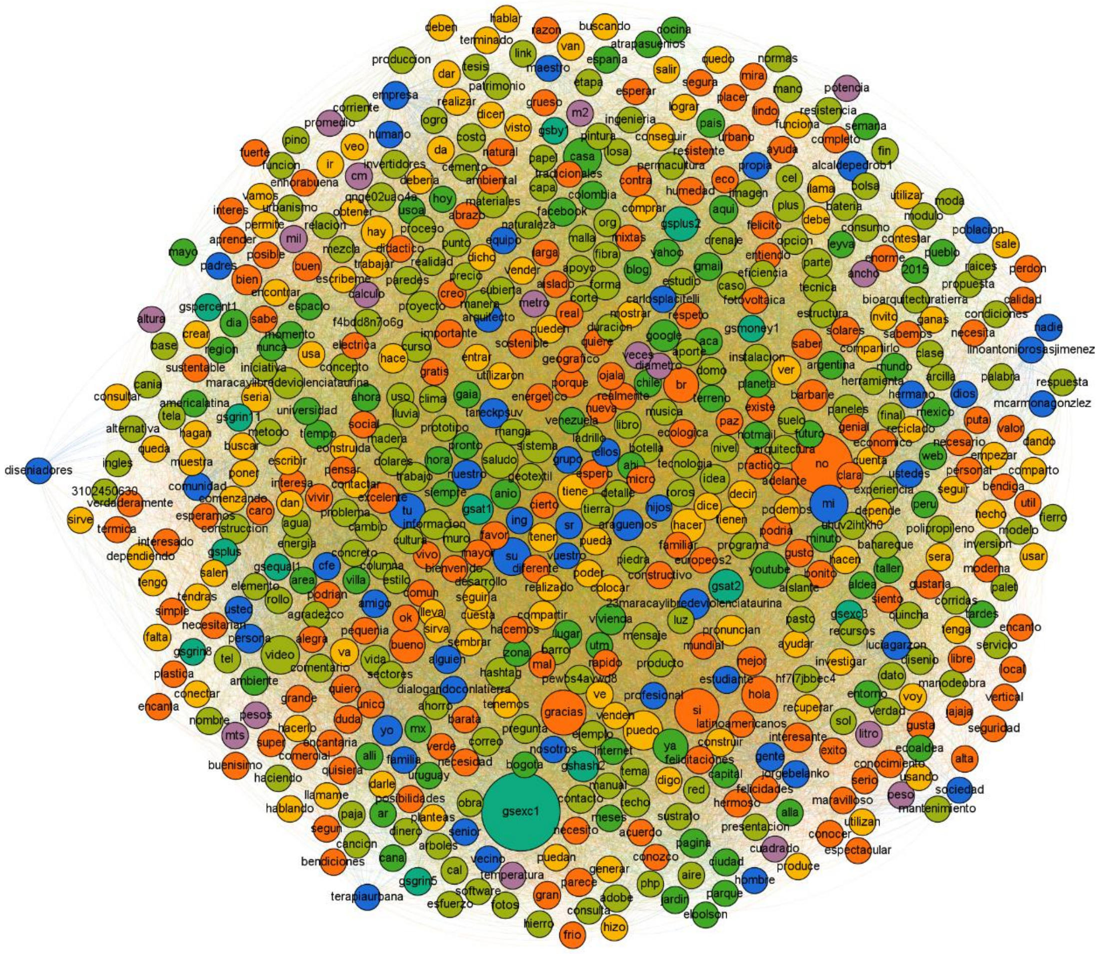
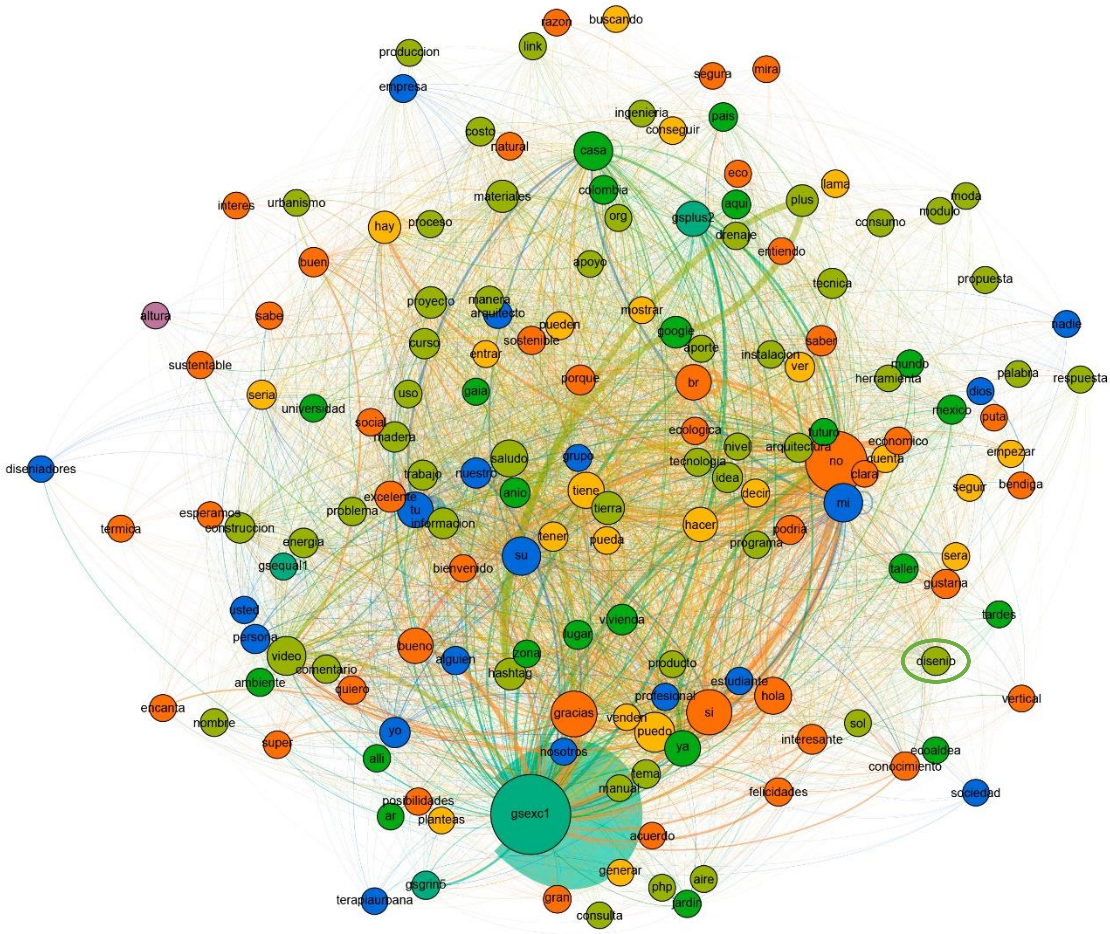


Figure 56 shows words connected to *diseño* (design, located towards South East). Although there are both positive and negative descriptive terms, design is linked to *conocimiento* (knowledge), *interesante* (interesting), *vertical*, *sociedad* (society) and *económico* (economic); while terms related to aesthetics like *bonito* (pretty) were not linked to design, but affective terms like *encanta* (love) were. In sum, descriptive terms related to design tended to be objective, although there were more subjective words linked to it than in SDEN. Consider the following comment (translated and used with permission) by Civil Engineer Ricardo Pizarro Iturrieta:

"The video is clear for professionals with knowledge, who understand the logic, materials, the design of sustainable architecture, usage of renewable energy, how it is incorporated in the design, and mainly how to take advantage of the sun, wind, etc. I regret the written comments that leave much to be desired in this panel, especially the ignorance they vomit, unfortunately these spaces of comments are with a right of probity and we

must respect those who issue them, to the users who leave bad comments I tell them to switch the channel and leave these spaces to thinking people."

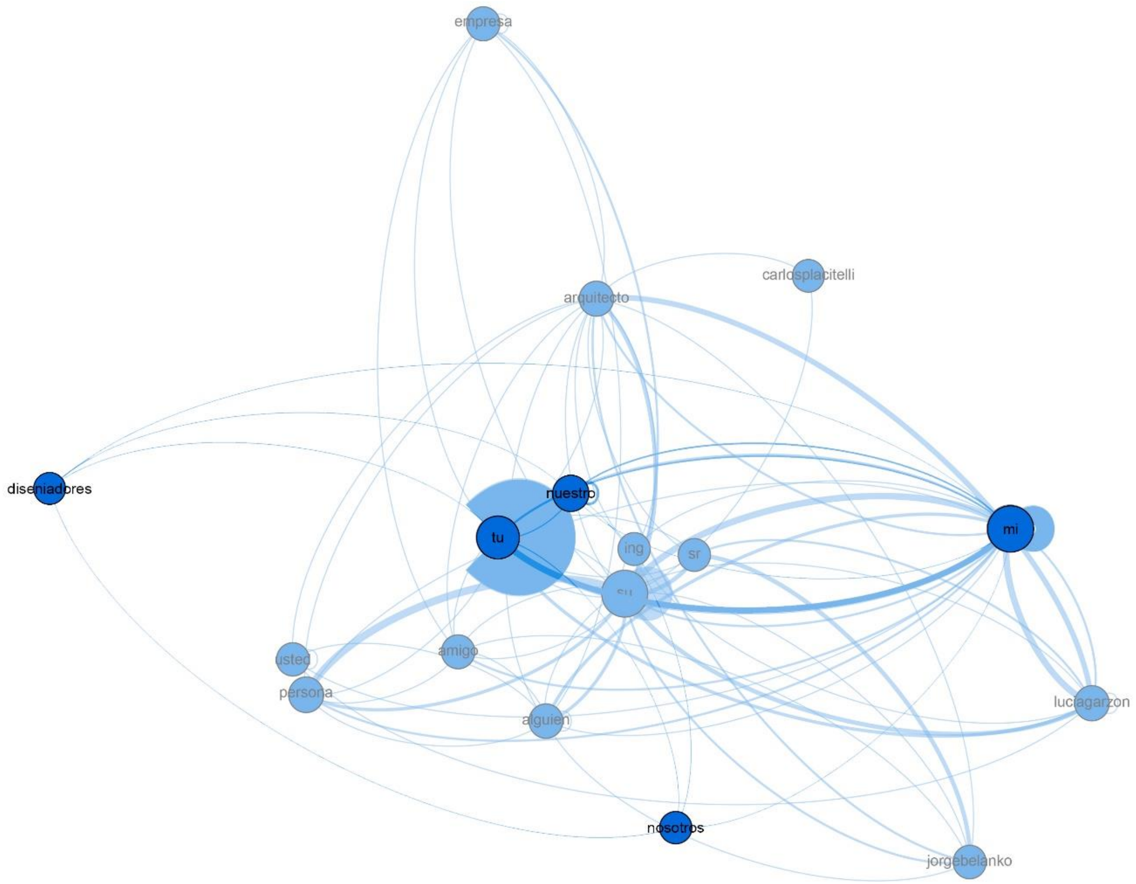
Figure 56. Words connected to Design in SDES A-list Semantic Network



As for relationships between living beings, the distribution of nouns and pronouns is dispersed, being *mine* and *your* the biggest nodes. The strongest relationship between nouns and pronouns was between *hermano* (brother) and *tú* (you), which was 20 times forth. This suggests some amiable conversations between users.

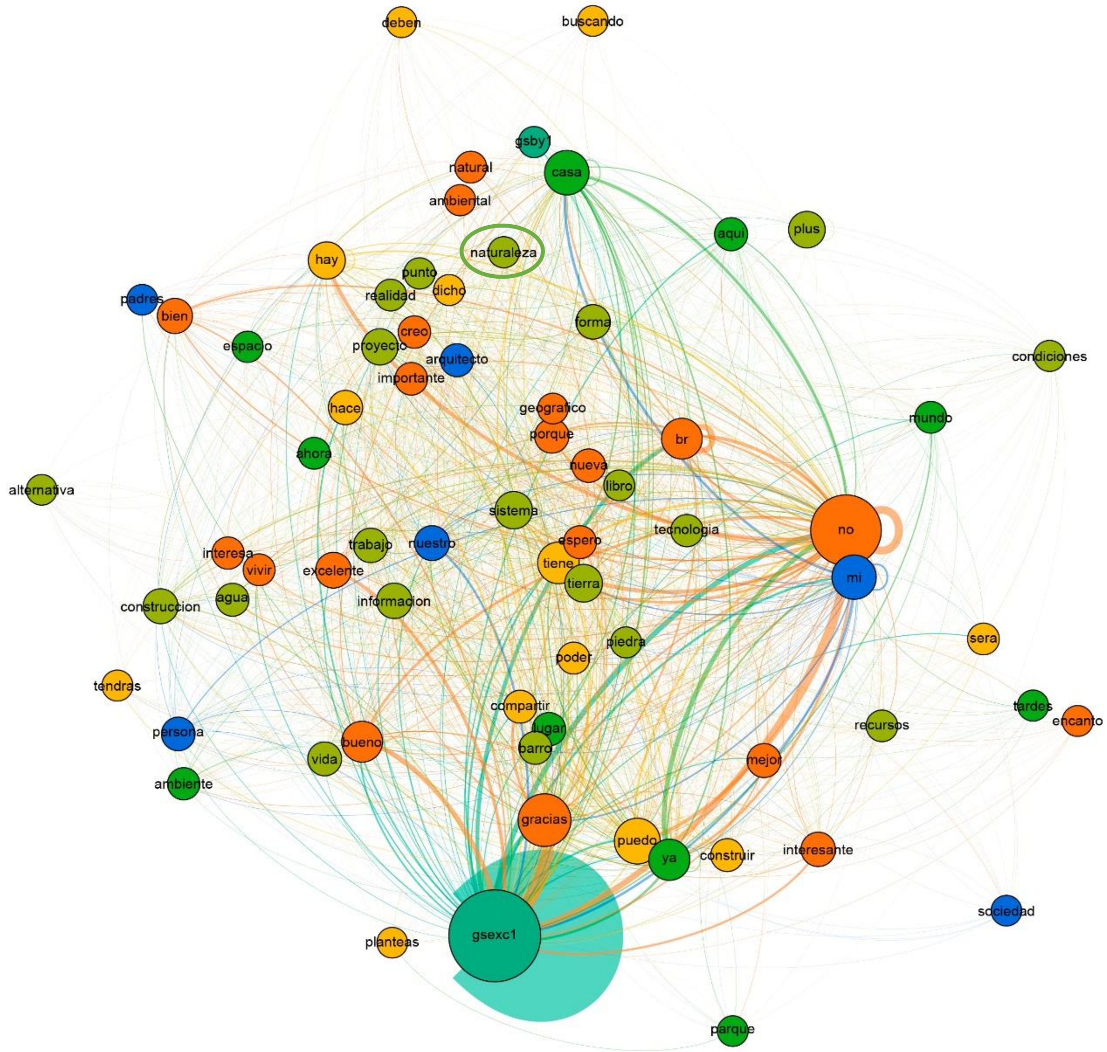
Relationships between designers and other stakeholders were also explored in this network. Figure 57 shows that *arquitecto* (architect, located on the upper area) was mentioned in comments related to a wider range of stakeholders than *diseñadores* (designers), in similarity with SDEN estimations.

Figure 57. Intersection of stakeholder relationships for the words *arquitecto* and *diseñadores* in SDES A-list network



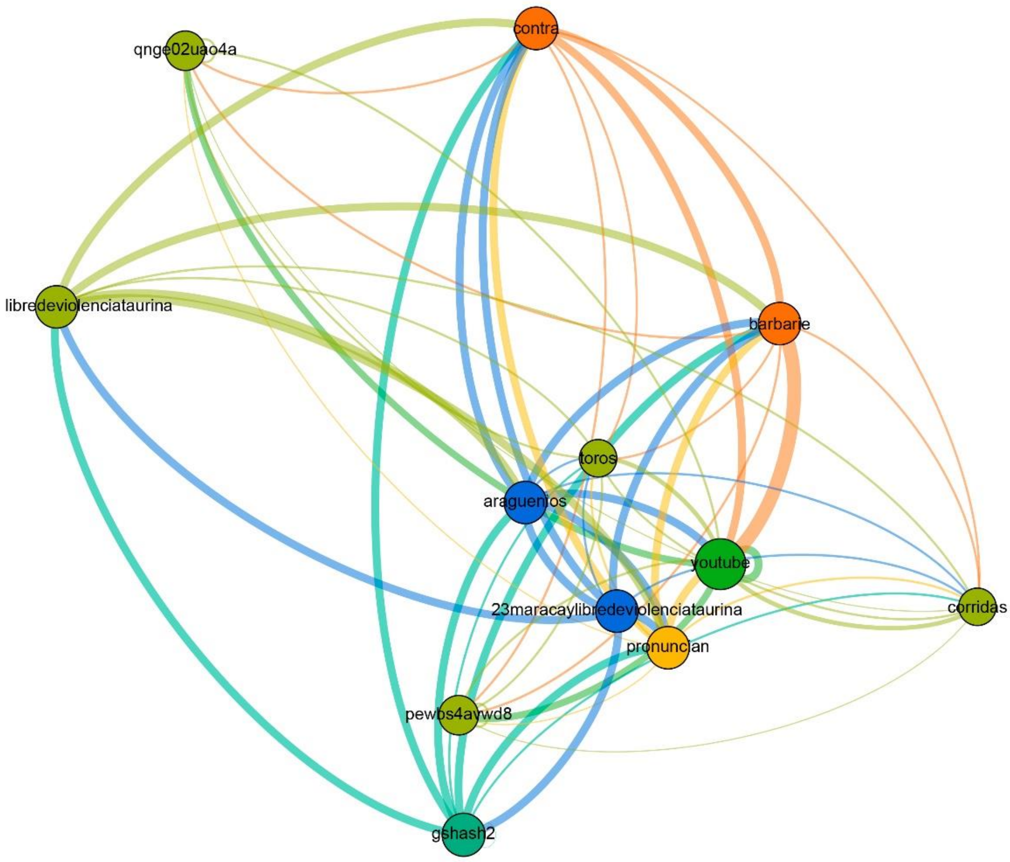
Non-human beings were less mentioned in this network. Relationships between nature and production could be appreciated in Figure 58, with a view of the environment as a resource, both of raw materials and knowledge.

Figure 58. Words connected to *naturaleza* (nature) in SDEN A-list Semantic Network



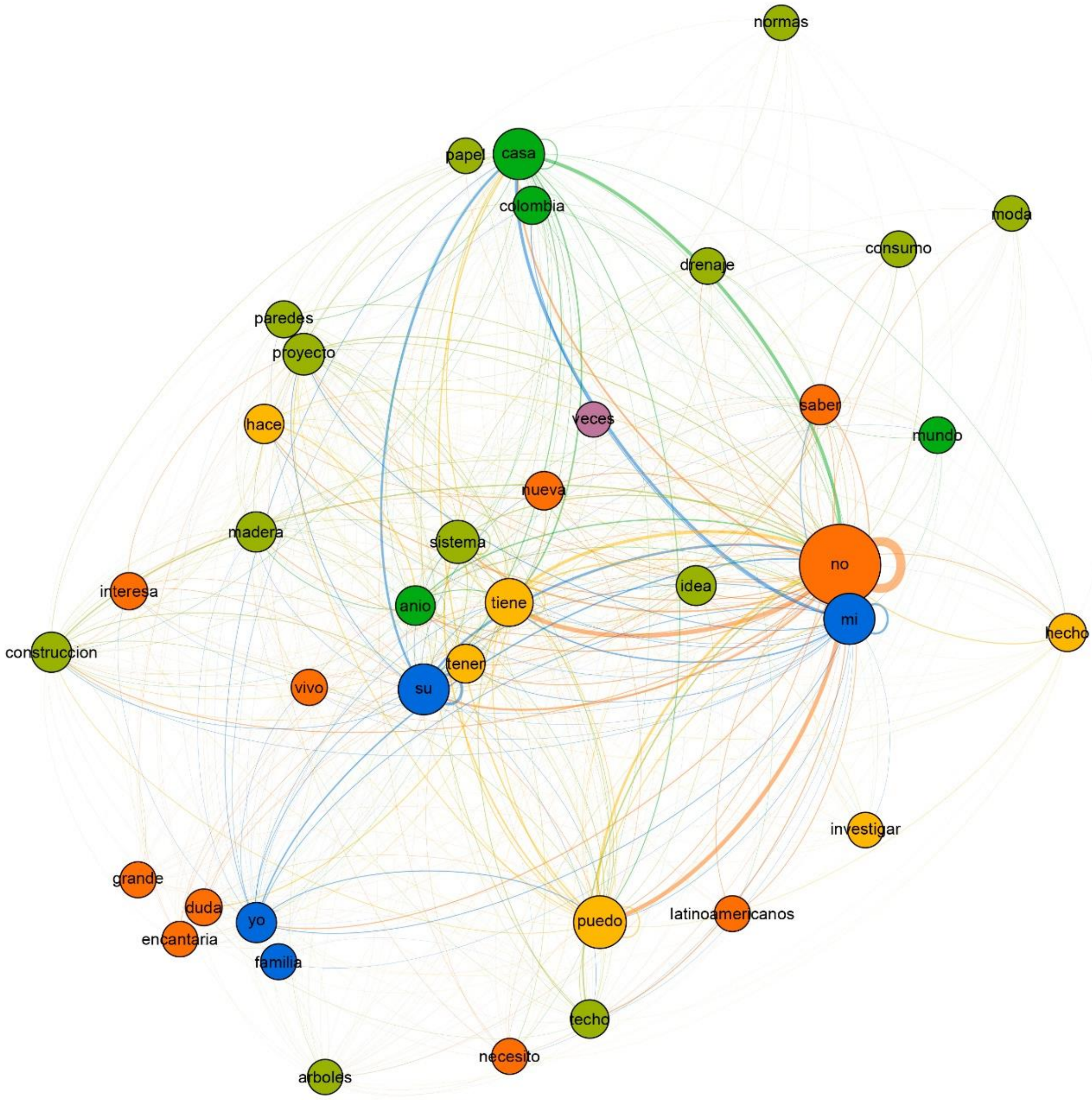
The only term related to animals in SDES was *toros* (bulls), part of a cluster related to an anti-bull fighting campaign, as can be appreciated in Figure 59. This suggests a view of animals as victims, and our treat of them as negative, in a similar fashion to SDEN.

Figure 59. Words connected to *toros* (bulls) in SDES A-list Semantic Network



As for trees, they were connected to design projects mostly in architecture and to a lesser extent, fashion, as shown in Figure 60. Plants were not among the most frequent words in Spanish, in contrast with SDEN. Such relationships suggest a view of nature as production materials and as inspiration for design, meanwhile animals are perceived as negatively affected by human behaviour but positively by a design process (e.g. the campaign against bull-fighting).

Figure 60. Words connected to *árboles* (trees) in SDES A-list Semantic Network



A directed graph for the Negative List was drawn and explored, including 486 terms organized through the Force Atlas algorithm. Figure 61 represents the graph, where node size corresponds to word frequency and tie thickness to the words' relationship strength. Although the A-list showed a great variety of positive and grateful words, the Negative list network makes possible to explore negative terms and their relationships. Words like *mal* (wrong) and *malo* (bad) were connected to government related terms, *consumo* (consumption) and several construction technique names. The term *dificil* (difficult) was tied to several design objects, techniques and materials. Thus, negative emotions (and psychological barriers to adopt sustainable design) were mostly related to socio-political systems and lack of practice and expertise.

Figure 61. Negative List SDES Semantic Network

(N=486, Node size = 706 to 1, Tie thickness =1166 to 1)

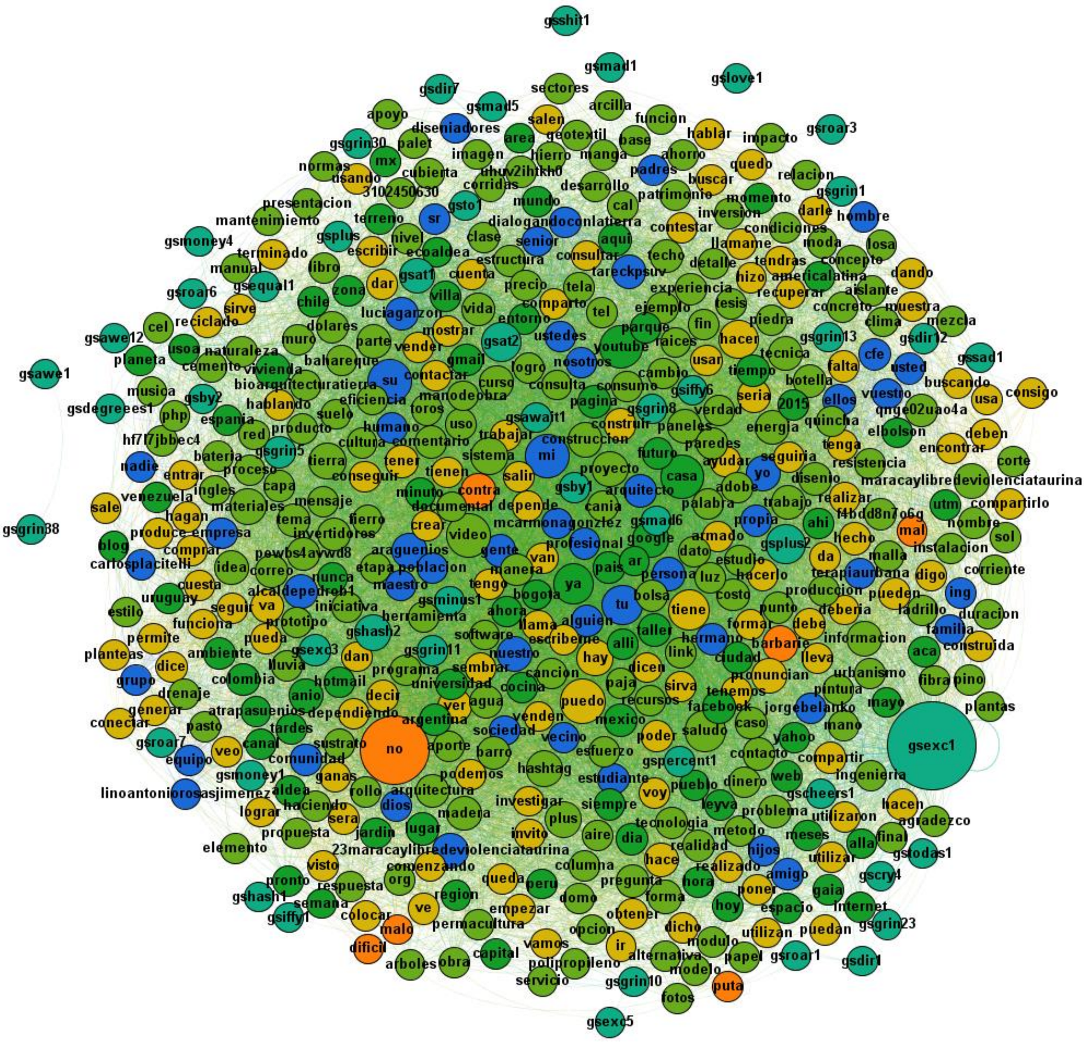


Figure 62 represents a directed graph for the 236 List, which included 424 words organized through the Force Atlas Algorithm. Node size corresponds to word frequency and tie thickness to the words' relationship strength. Although most of the strong relationships were among terms related to the bull-fighting cluster, the word *compartirlo* (sharing) was frequently tied to the exclamation mark, while other graphical symbols tended to be interconnected. Moreover, *construir* (build) was connected to both positive and negative words and graphical symbols, while *aprender* (learn) and *crear* (create) were mostly connected with positive terms. The word *adaptar* (adapt) was not related to graphical symbols, which might imply that it was used in more objective scenarios.

Figure 62. Semantic Network of SDES 236 List

(N=601, Node size = 706 to 1, Tie thickness = 38 to 1)

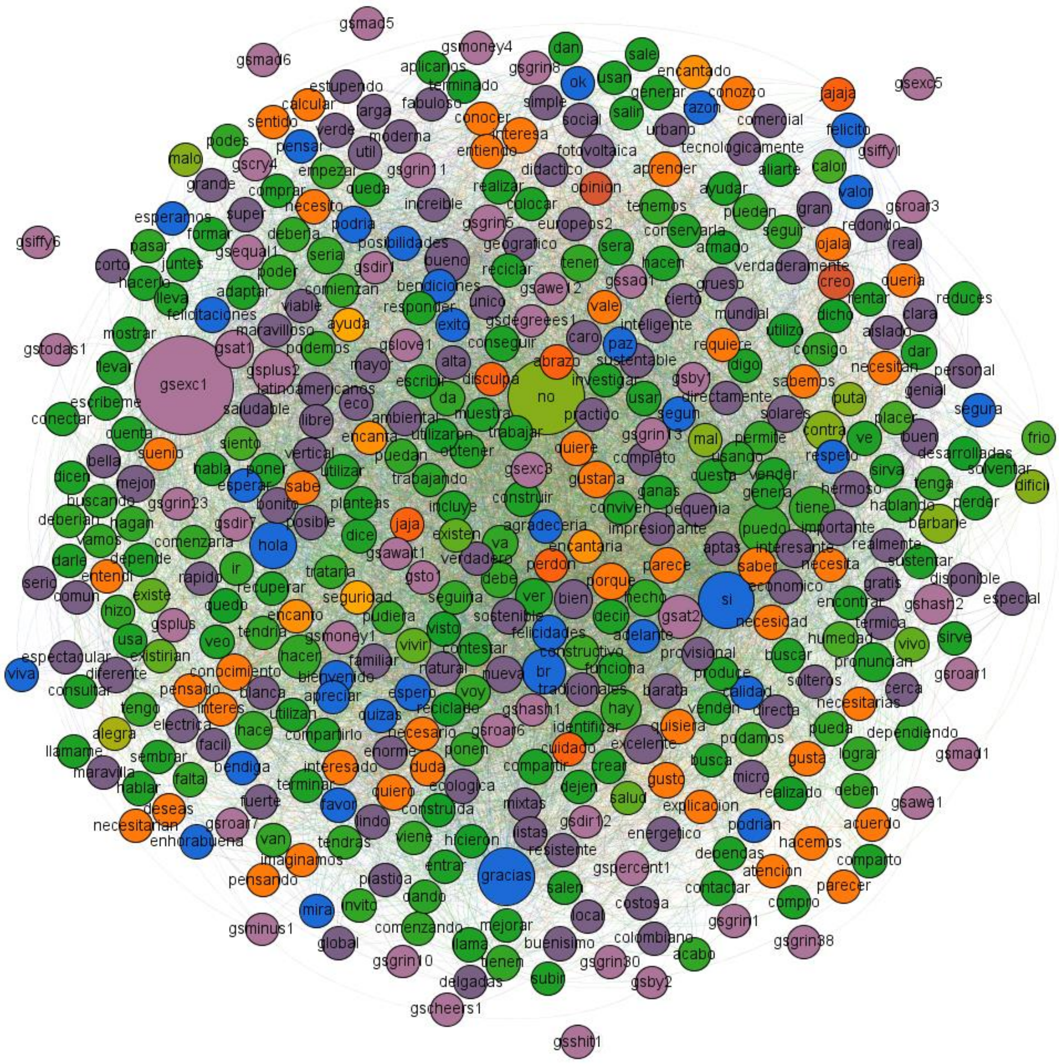
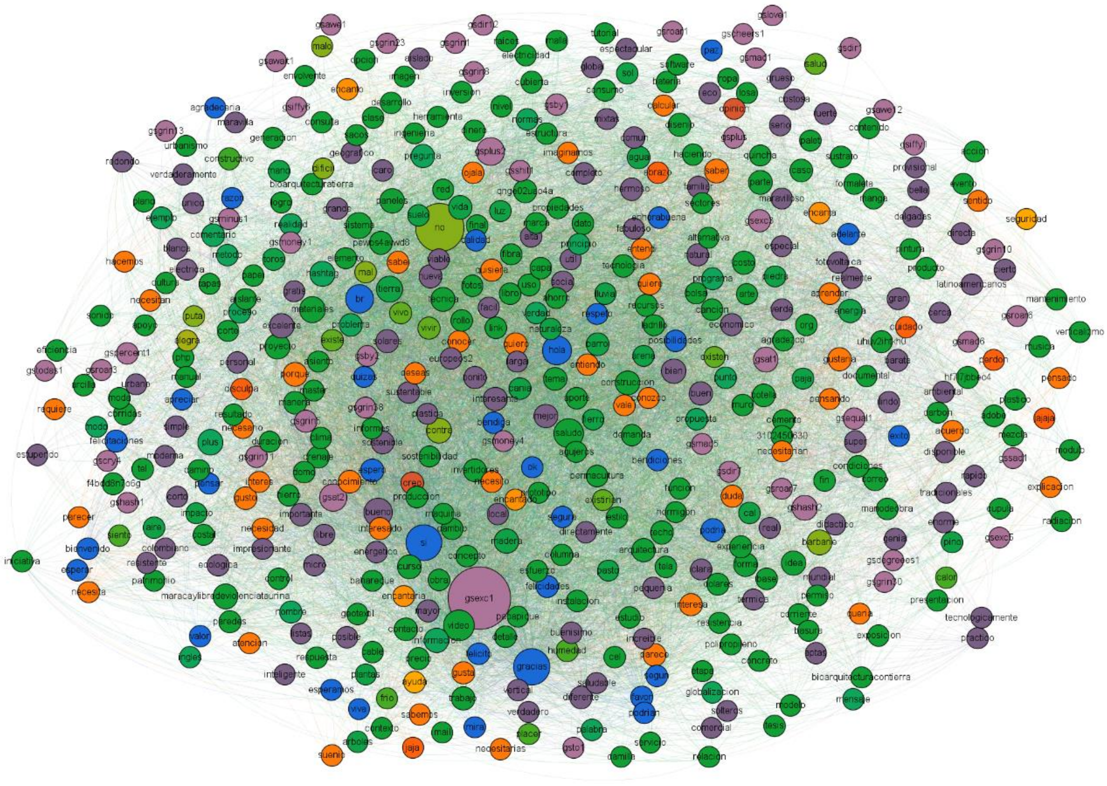


Figure 63 represents a directed graph for the 246 List, which includes 497 words organized through the Force Atlas algorithm. Node size corresponds to word frequency and tie thickness to words' relationship strength. Resources like adobe, *arena* (sand), *pino* (pinetree), *aire* (air), *lluvia* (rain) and *pasto* (grass) were connected to positive terms, which might imply ecophilia. The word *music* was tied mostly to positive terms, which supports the assumption that music could affect the video favourably, as in SDEN. The word *hermoso* (beautiful) was connected to *documental* (documentary), *información* (information), *plantas* (plants), *proyecto* (project), *trabajo* (work), and several other terms, which suggests a subjective evaluation of design.

Figure 63. 246 List Semantic Network

(N=497, Node size = 706 to 1, Tie thickness =1166 to 1)

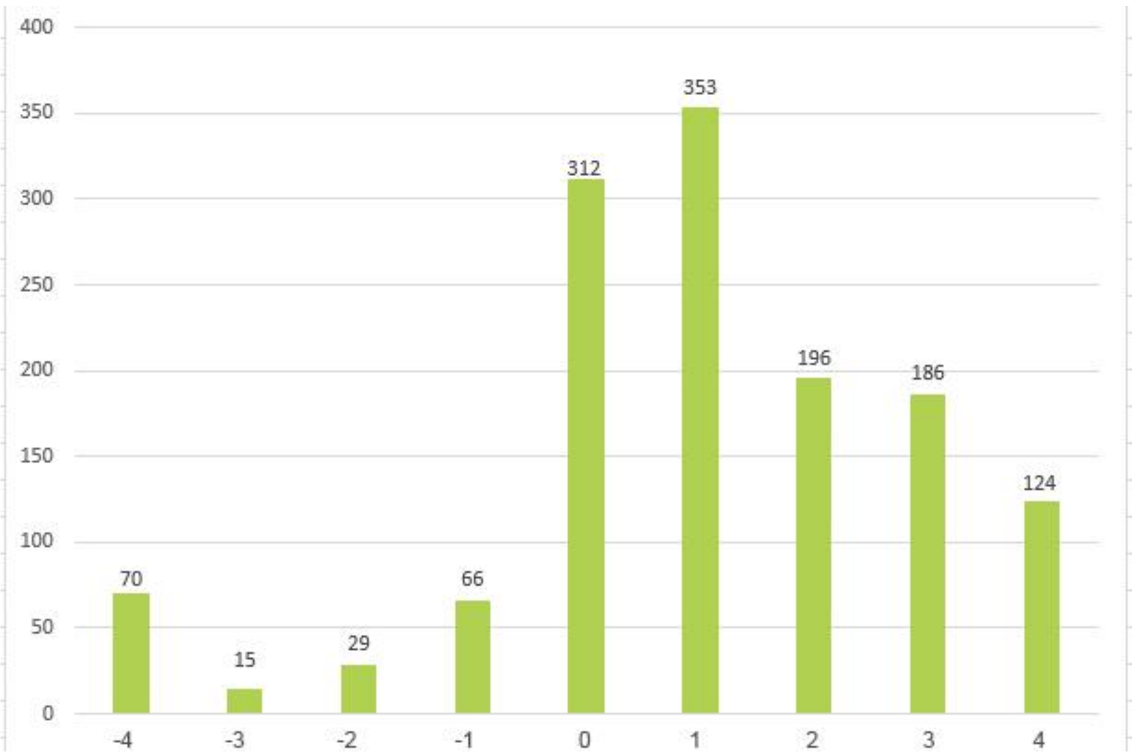


Both positive and negative words were tied to *agua* (water), *árboles* (trees), *arcilla* (clay), *barro* (mud), *caña* (cane), *hierro* (iron), *madera* (wood), *paja* (straw) and *plástico* (plastic). In the case of trees, they were also connected to the term *vivos* (alive), which suggests ecophilia as well. Among cognitive words, *conocimiento* (knowledge) was tied to *cultura* (culture), *dólares* (dollars) and graphical symbols of grins and money; while *saber* (knowledge) was connected to project related terms, a wider range of positive words and no graphical symbol with emotional expression. This is probably due to the usage of both terms, being *saber* a more practical type of knowledge than *conocimiento*. It should be noted that this network did not show the graphical symbols in a ring, in contrast with SDEN.

16.2.5. Sentiment Polarity of SDES Comments

Figure 64 shows the number of comments in Spanish according to their SentiStrength score. The X axis represents the score and the Y axis, number of comments. The score reflects the sum of the two polarities (positive and negative), where zero means neutral. Average polarities were (2.6410, -1.6417), which implies a wider emotional range than SDEN. Most comments (859, 63.20%) were positive, followed by 312 (23.09%) comments with neutral polarity, and 180 (13.32%) comments with negative polarity. Emotionality score was calculated, which gave an average of 4.28. Thus, Emotionality was higher on this sample than in SDEN.

Figure 64. Sentiment Polarity in SDES (N= 1351)



A qualitative analysis in random comments with maximum positive polarity (5,-1) found that such messages vary in length, tend to be focused on speakers, design objects and include graphical symbols. In contrast, maximum negative messages tended to be short. They also had a tendency for analysis and criticism of the design object, while negative emotions towards economic and government factors were found. Next, a qualitative analysis in random neutral comments (2,-2) was conducted. Such comments tended to be long and rational. Justification and criticism towards design, and rejection towards individualism and a sense of community were also found.

16.2.6. Sentiment Category of SDES Comments

Figure 65 shows scores in the Y axis, while the X axis corresponds to the eight basic emotions according to Plutchick. Once more, Trust had the highest score, followed by Joy, Anticipation, Sadness, Fear, Surprise, Anger and Disgust.

Figure 65. Sentiment Category Scores in SDES (N= 1351)

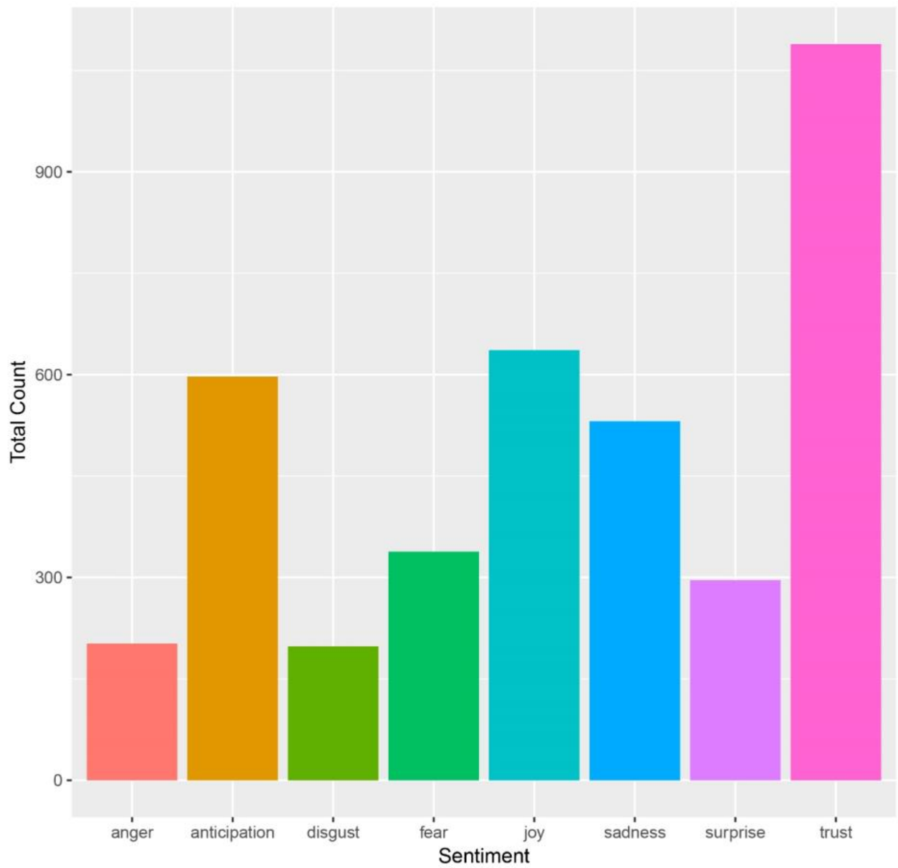
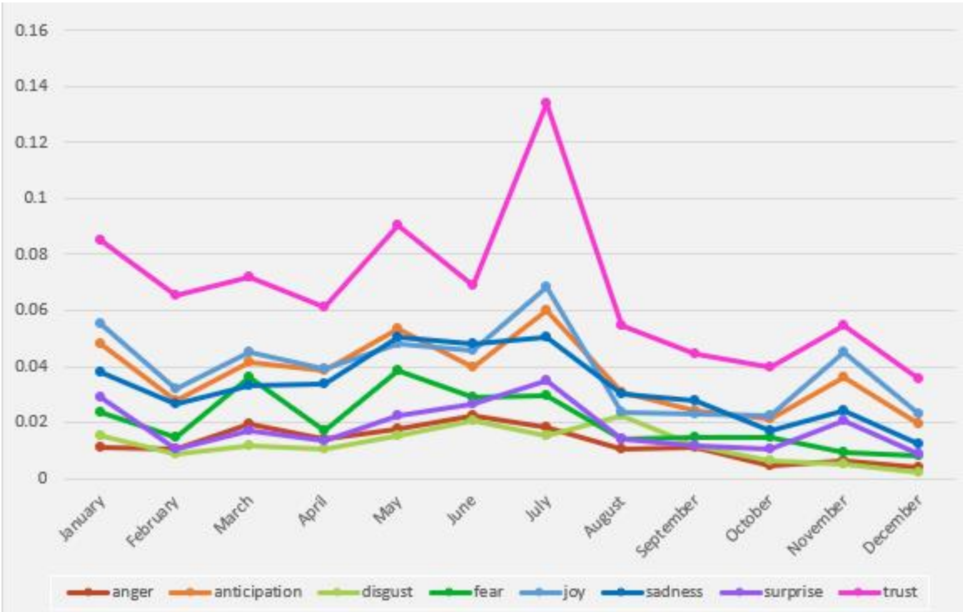


Figure 66 shows emotional peaks across time, with the X axis representing the months and the Y axis, average sentiment scores. It can be noted that highest emotional peaks are in January, May and July, while emotions mostly decline in September, October and December. The only month that coincides in terms of emotional peaks with SDEN is January. Peaks in July coincide with the videos against Bullfighting and workshops related to *Dialogando con la Tierra*, an NGO funded by architects to diffuse sustainable architecture. Sentiment peaks roughly correspond with videos posting volume from April to July, as can be noted in Figure 18. Moreover, sentiment peaks roughly correspond with comments post volume per month shown in Figure 49. This might indicate a stronger time dependency in this video network and a higher emotionality score per comment, which coincides with the SentiStrength evaluation.

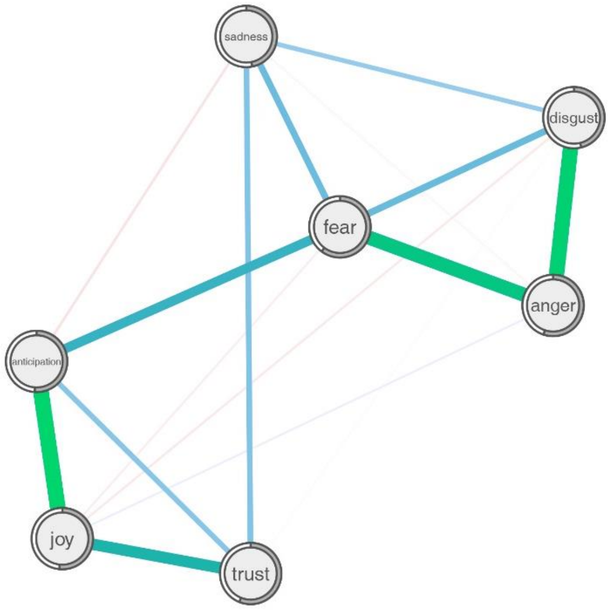
Figure 66. Sentiment Category per Month in SDES (N= 1351)



A network of sentiment types was also estimated for SDES. Surprise was slightly unreliable when a random sample of comments was crosschecked with the scores, so it was not taken on account for the network. Low scores in Anger and Disgust were unreliable as well, partly due to the small amount of comments containing such sentiments in the samples. However, the Spearman correlation-based network of seven sentiment types was similar (see Annex 28), correlation between sentiment means and standard deviations was high (r_s=*0.964, p<0.01*) and correlation between sentiment means between the two languages was high as well

(r_s=0.857, p<0.05). Thus, Anger and Disgust were incorporated to the Spanish sentiment network estimation. Figure 67 presents the network graph with each node representing a sentiment, each ring reflecting sentiment predictability and tie thickness representing polychoric correlation.

Figure 67. SDES Sentiment Category Network



In this network, the main bridge between positive and negative emotions is also Anticipation and Fear. Other bridge is Sadness and Trust, which might be representing a transition between acceptance and pensiveness, according to Plutchick's wheel. Another feature of this network is a stronger relationship between Fear and Disgust than in SDEN. Moreover, the strongest ties were between Joy and Anticipation (optimism), and Anger and Disgust (contempt). Overall predictability was not as good as in SDEN, but once more, Fear was the highest.

Table 38 shows the summary of a qualitative analysis in ten top comments in terms of sentiment scores. Similarities with SDEN results were marked with asterisks. The Spanish comments tended to ask questions, which coincide with the interest reflected in the Anticipation score. Joy was distinctively positive, in contrast with SDEN results. It is noted that comments contained a more classical view of ecophobia linked to Sadness, Fear, Anger and Disgust, also deeming natural elements as *dirty*. Role models in the comments were both male and female. However, a few of the top comments were so similar that they might have been posted by a bot or users with an agenda, just as in SDEN.

Table 38. Summary of Qualitative Analysis on Top SDES Comments in Terms of Sentiment Category Scores

Trust	Joy
• Long arguments mostly in favor of bioarquitecture with a systems perspective.	• Acceptance of sustainable design with deep analysis.
Anticipation	**Sadness**
• Mostly interest on sustainable design.*	• Dirty nature. • Government. • Ineffective design. • Money. • System.*
Fear	**Anger**
• Dirty nature. • Government. • Ineffective* and ugly design. • Low quality in video. • System. • Usage of non-conventional methods. • YouTube users.	• Dirty nature. • Government. • Ineffective and ugly design. • Low quality in video. • Money. • System.* • YouTube users.
Disgust	
• Dirty nature. • Ignorance.* • Ineffective design. • Low quality in video. • Waste.	

Ten comments with a value of 1 in terms of Trust, Anticipation, Joy, and ten comments with a value of 1 and 2 in terms of Sadness were analysed. The other sentiments did not have enough aisled scores, which implies that Fear, Anger, Disgust and Surprise were mixed with other emotions. This assumption is also supported by the estimated sentiment network in the case of Fear, Anger and Disgust. Similarities with SDEN results appear with an asterisk in Table 39. Also, a double asterisk highlights characteristics shared with SDEN comments found in videos from developing countries in Africa and South Asia. The constant mention of a suitable context should be noted. Sadness was connected to several factors including the design object, the economy and the planet. In general, a healthier relationship with people than in the case of SDEN was present.

Table 39. Summary of Qualitative Analysis on Aisled Sentiment Category Scores in SDES Comments

Trust	Joy
• Acceptance of sustainable design methods and role models. • Acceptance of YouTube users. • Rejection of design due to lack of context. • Commenters completed information.	• Sustainable design is cheap.* • Sustainable design is beautiful. • Role models are modest.* • Acceptance of people.
Anticipation	**Sadness**
• Interchange of personal information between users.** • Mostly interest for sustainable design.	• Incompetency • Ineffective design • Lack of information • Lack of quality in the video • Lack of relevant context • Money • Planet

16.2.7. Correlation and Regression Analysis in SDES Comments

A Non-Parametric Correlation Analysis between top 14 word clusters, sentiment polarity scores and seven sentiment category scores was conducted in SDES (Table 40). Results coloured in dark green were correlations, while those coloured in light green were considered as slight correlations. Word clusters were more correlated with positive sentiments, in contrast with SDEN. Clusters with strong multiple correlations were clusters 2 *System*, 5 *Economy*, and 8 *Latinamericans*, which were topics about relationships to diverse factors and people. Clusters 6 *Adobe*, 11 *Energy* and 12 *Information* did not have strong correlations with emotions, suggesting that topics about engineering and architecture were more objective.

Table 40. Spearman Correlation between Word Clusters and Sentiment Scores in SDES

	1 Jorge	2 System	3 Bullfighting	4 Economy	5 House	6 Adobe	7 Chile-US	8 Latin Am.	9 Mexico	10 Housing	11 Energy	12 Information	13 Earth	14 Lucia
Positive	.503**	.117**	-.257**	.210**	.136**	.152**	.132**	.229**	.104**	.132**	.142**	.126**	.092**	.078**
Negative	.100**	-.294**	-.390**	-.144**	-.089**	.006	-.127**	-.066*	-.117**	-.112**	-.041	-.040	-.173**	-.022
Anger	.074**	.301**	-.060*	.236**	.128**	.045	.129**	.096**	.079**	.093**	.087**	.071**	.172**	.133**
Anticipation	.187**	.279**	-.081**	.296**	.170**	.147**	.228**	.329**	.155**	.151**	.193**	.135**	.210**	.231**
Disgust	.068*	.291**	-.062*	.228**	.091**	.050	.150**	.115**	.066*	.099**	.154**	.156**	.144**	.067*
Fear	.144**	.339**	-.057*	.219**	.138**	.067*	.224**	.109**	.107**	.182**	.160**	.082**	.256**	.095**
Joy	.310**	.179**	-.110**	.172**	.148**	.096**	.208**	.308**	.127**	.172**	.191**	.127**	.168**	.175**
Sadness	.187**	.302**	-.117**	.223**	.147**	.114**	.238**	.238**	.109**	.175**	.143**	.092**	.231**	.032
Trust	.250**	.374**	-.142**	.305**	.213**	.138**	.287**	.322**	.214**	.254**	.199**	.149**	.312**	.217**
N=1351. **P<0.01. *P<0.05.														

Results of regression analysis can be consulted in Table 41, where scores above 0.15 in terms of Adjusted R Square were considered good predictors of sentiments. Words that were better predictors were also related to people and the economic system in Spanish (Clusters 1 *Jorge*, 2 *System*, 4 *Economy* and 8 *Latinamericans*). The exception was Cluster 3 *Bullfighting*, which contained texts so similar to each other that they were probably automatically generated or generated by grassroots actors, instead of designers or design consumers themselves. Clusters related to energy, engineering and design scored lower than .15, suggesting more objectivity in these topics again.

Table 41. Rank Regressions on SDES Word Clusters

Dependent Variable	F	R Square	Adjusted R Square
1 Jorge	58.618	0.282	0.278
2 System	53.481	0.264	0.259
3 Bullfighting	51.402	0.256	0.252
4 Economy	31.952	0.177	0.171
8 Latin Americans	30.211	0.169	0.163
13 Earth	25.173	0.145	0.139
7 Chile - US	20.02	0.118	0.113
10 Housing	13.716	0.084	0.078
14 Lucia	12.245	0.076	0.07
11 Energy	11.454	0.071	0.065
5 House	10.131	0.064	0.057
9 Mexico	9.467	0.06	0.053
12 Information	7.649	0.049	0.042
6 Adobe	6.575	0.042	0.036
Independent variables: Positive Polarity, Negative Polarity, Anger, Anticipation, Disgust, Fear, Joy, Sadness, Trust.			
N = 1351 Regression = 9, Residual = 1341, P<0.000			

17 DISCUSSION

17.1. Characteristics Of SDEN Comments

17.1. 1. Theory Orientation

There was indication of theory orientation in section 12.1, confirmed with the amount of Kansei words included in the A-list (36%), the cognitive related words (4.8%), and the presence of such words in cluster 1 *James* and 2 *Ignorance*. Moreover, cluster 2 was a slight predictor of feelings and was significantly correlated with negative polarity. This result reflects: a) the development of the

English YouTube network, which allows faster access and a wider variety of content than for SDES videos; and b) classical views of design rooted in European rationalism, where definitions and standards are important.

17.1. 2. Aversion towards War

The word *war* was among the top frequent and belonged to the Cluster 13 *Jacque*. This cluster was slightly correlated with negative polarity, disgust, and fear. 10 random comments with disgust score equal to one showed disgust for war; and 10 random comments with average sentiments (which included anticipation, fear, joy and trust in the same comment), suggested fear of war. Cheung-Blunden & Blunden (2008) found that those with green political views were less likely to support war, being fear the most explanatory emotion in a hierarchical multiple regression analysis; while anger was a significant predictor for being in favour of war. Thus, the present study also suggests aversion towards war among commenters of YouTube videos about sustainable design.

17.1. 3. Negative Views on Religion

The word *religion* was among the top frequent and belonged to the Cluster 13 *Jacque*, which was slightly correlated with negative polarity, anger, and sadness. Also, 10 random comments with anger and sadness scores equal to one suggested negative sentiment towards religion. It could be assumed that such opinions are mostly hold by seculars, as Christianity and Islam include the concept of stewardship for the Earth. While Muslims frame responsibility for the living planet in terms of being watched by God, Christians view it in a more humanistic way of doing what you would like others do for you and seculars are closer to the socio environmental views of Muslims; and religious people tend to perceive environmental risks as less grave (Hope & Jones, 2014).

Thus, a sense of urgency to act combined with the technological approach favoured in the videos content might be behind the negative perception of religion. Evangelical Christianity views in the U.S., which tend to be conservative, might be generalized towards other religions by non-religious people.

Probably the most concerning aspect of an extremely negative attitude towards religion is a focus on only objective aspects of the design process and its result. A study of conflict in multicultural high-tech companies revealed that religion was perceived as a category outside engineering practice, although vegetarianism among Hindus and Islamic prayers were viewed as negative by Germans (particularly atheists), while practitioners perceived their religious practices as individual choices (Mahadevan, 2012). In fact, a conflict between professional expertise and religion as a private issue was causing mistrust between co-workers (Mahadevan, 2012).

Spirituality was eroded in northern Europe through religious reform, eradication of traditional ways of life and the rise of scientific methods (Walker, 2013), which contributed to the separation of the physical/objective and the non-physical/subjective, but also to the confinement of subjective aspects like emotions and religion to the private life. In short, Walker (2013) argues that various interpretations of spirituality can provide ethical perspectives, meaningfulness and contact with the divinity of nature and non-human beings, which in turn can be oriented towards the design practice. Furthermore, Kim (2017) proposed an integration of ecological consciousness in Asian religions and Christianity, conciliating to a certain point, monotheistic and polytheistic views.

It makes sense that, after years of focus in UX design, where designers consider users in an integral manner, the next step would be to reconcile the designers with their own cultural, spiritual, intuitive and emotional selves. Rather than considering it a linear process, it should be a circular process, where a designer is capable of integrating the best and managing the worse of their subjective characteristics to design with the other stakeholders involved, being also capable of integrating the best and managing the worse of the stakeholders' subjective characteristics. Examples can be found in Rogal (2012), Cortes Lefranc (2017) and Akama (2018).

Organized religion has condoned many crimes against humanity, non-human beings and the living planet. However, if there is something designers can learn from religious systems is their efficiency in terms of knowledge and aid distribution. Regarding justice, several Christian theologies of liberation were active around the world between the 1960's and the 1970's against military governments in Latin America, during the South African Apartheid and helping the struggle of Dalit communities in India (Tomalin, 2015).

Some Christian branches have become active in environmental politics (Thackara, 2012), while Mosques have participated in initiatives like the African Muslim Environment Network (Alliance of Religions and Conservation, 2018), the Green Mosques in UK (London Sustainability Exchange, 2018) or the Green Mosque Project in the U.S. (Qidwae, 2018). Therefore, religion is an aspect that should not be demonized or considered as a private issue by designers, as it can be a useful feature to organize collective action in relationship to sustainability.

17.1. 4. Some Biophilia and Fear of Natural Disasters

The words *love* and *animal* were connected 13 times, and cluster 6 *Holistic* was about the living planet. Also, cluster 6 slightly predicted sentiment scores, being significantly correlated with Trust and Joy. However, Cluster 6 was significantly correlated with Fear and a qualitative analysis on comments revealed it was linked to natural disasters.

Biophilia can be defined as the love for life and living creatures (based on Fromm, 1964). This emotion is studied in children education, but rarely in adult education. Commenters of SDEN acknowledged the life mostly of animals. Therefore, an interest on living creatures is related to sustainable design. This finding is consistent with war rejection in the comments, which implies disgust towards destruction of life.

A strong love for the world has a close relationship to compassion, according to Edmonds (2018), which can not arise if someone is not open to feeling suffering. Once the pain makes the loss feel real, two things might occur: we communicate that pain and find empathy among our peers (to the extent of offering help to act) or we keep it to ourselves for fear of not being accepted. Although there is considerable work in the process of dealing with pain and propel people into proactive action (e.g. Johnstone & Macy, 2012; Brown & Macy, 2014), the exact mechanism has not been described. However, networks of the present study suggest that the more effective and healthier a network is, the easier it is to act, which might contribute to alleviate the pain.

Fear for natural disasters was also found. Although this description can be included in ecophobia (defined as the worry over environmental degradation), there is a more specific word linked to this type of fear. Albrecht coined the term *solastalgia* for "the pain experienced when there is recognition that the place where one resides and that one loves is under immediate assault" (Smith, 2010). Again, this finding is consistent with rejection for war found in the comments. The fact that there was little biophilia and ecophobia in the comments might reflect an avoidance of thinking about the pain of losing the living planet. This avoidance may cause a sort of blocking that is particularly paralyzing for creative endeavours, where as many possibilities as possible should be considered, even if they elicit negative emotions in us.

17.1. 5. Environmental Privilege and Racism

Environmental privilege can be defined as "the taken-for-granted structures, practices, and ideologies that give a social group disproportionately high level of access to environmental benefits" (Liévanos, 2010). The word *white* belongs to the Cluster 5 *People*, which was the highest predictor for feelings. Cluster 5 was more correlated with negative than with positive polarity. The word *Nazi* was in the cluster 10 *Science-Technology*, which was also a slight predictor of feelings. Further, cluster 10 was more correlated with negative than with positive polarity. Top 10 comments in terms of Anger and Sadness showed arguments about the role of developed countries in keeping developing countries underdeveloped. Also, because scores for Anger and Sadness through time looked like they were raising and descending together, a qualitative analysis on 10 top comments with anger and sadness scores equal to one was performed. This showed that such feelings were connected to lack of human diversity.

According to Norgaard (2011), "privileged people's experiences and normalizing strategies have remained invisible in that they are regarded as neutral and universal within social psychological theories". Many of the top videos were uploaded from the U.S., where a conceptualization of race as binary is the base of national identity. However, climate change affects the South mostly. In Latin America, phenomena like *El Niño* worsen, affecting the distribution of infectious diseases (Grupo Intergubernamental de Expertos sobre el Cambio Climático, 2001). Such disasters provoke migration waves that have already been framed as “them vs. us” by authoritarian governments and media from WEIRD countries, further legitimizing racism.

Through UX design and Universal design, academia attempted to integrate a social dimension to design practice by focusing on users with special needs. Nevertheless, the design process is still far from integrating migration, human security issues and imminent environmental destruction. In other words, people in WEIRD countries can feel great designing a watch for the visually impaired without bearing in mind the components that will expose non-WEIRD countries to health hazards.

Interchange of views between privileged and non-privileged YouTube users might be chaotic and painful sometimes, but it is necessary. Not all users hold solid prejudices, and by coming in contact with humans who have radically different life experiences and opinions, they might become keener to listen and collaborate with others. These are key characteristics desired in designers that have potential to enrich the design process. Taking on account that one of the top word bigrams was “I agree”, that several comments expressed an effort to understand others point of view, and that argumentation was (generally speaking) in a respectful manner, public niche cyberspaces like the design networks in YouTube offer an opportunity to enrich design education and practice.

17.2. Characteristics Of SDES Comments

17.2. 1. Project Focus

Spanish comments were mostly project focused, which confirmed the findings described on section 13. Most of the frequent words in A-list (30%) corresponded to direct objects. Number of clusters about materials and projects mainly in architecture (8 clusters from 14) was also high. This is considered as an advantage of the Spanish videos because designers were shown materializing ideas despite the many barriers that exist for sustainable design.

17.2. 2. More Individual Female Representation and Attributes related to Women

Although SDEN had cluster 4 *She* related to women designers, their names were not frequently mentioned. In Spanish, cluster 14 includes the name of a woman designer. Several women commenters were also found interacting often with other YouTube users. Thus, sustainable design aided the mitigation of the historical silence of women in design, particularly in Spanish Speaking countries.

Virtues traditionally assigned to women like receptivity and care are more present in this network. Literature on climate change, pro-environmental behaviour and gender treats non-WEIRD women as vulnerable and WEIRD women as virtuous advocates, which deflects attention from decision-making inequalities, fosters generalization and a North-South divide (Arora-Jonsson, 2011). In contrast, results of the present study highlight how Spanish speakers who are actively pro-environmental in the design field also tend to be cooperative, which contributes to foster the sense of community, empowerment and a Do It Yourself attitude. 5 of the 14 clusters were focused on information sharing and community building (1 *Jorge*, 4 *Economy*, 5 *Adobe*, 10 *Information*, 13 *Earth* and 14 *Lucia*). The first two clusters were significant predictors for feelings and they were more correlated with positive than with negative polarity.

Therefore, the present research provides evidence that unlinking virtues from specific genders is an effective strategy to foster pro-environmental attitudes and behaviours, which in turn can contribute to strengthen offline communities. When Latin American groups are developed around the craft industry, they often address issues which affect the entire community (Borges, 2014). For example, regional craft development programs and partnerships between designers and local artisans endowed the interruption of migratory human flows from the countryside to cities, (Borges, 2014).

17.2. 3. Expertise, Communication and Trust

Although both networks comments showed barriers for sustainable design, SDES commenters expressed intentions of doing it often. Given that many asked specific questions that denoted specialized knowledge, it can be inferred that many commenters were at least builders. Others were also looking for professionals who could design for them. As most obtained answers for their questions, the interactions tended to be long and cordial.

The high grade of trust in designers and other people reflected in the sentiment analysis was further noted in the public interchange of mails, names, telephone numbers and physical addresses. These communication patterns were also found in some SDEN videos from non-WEIRD countries, particularly Africa and South Asia. This aspect is important regarding the lack of self-confidence that is often characteristic of designers. Although most comments were related to architecture, this can help to motivate other types of designers.

17.2. 4. Lack of Resources and Information in Local Contexts

Lack of monetary, knowledge and professional resources was a worry for Spanish Speakers. In some cases, the proliferation of Do It Yourself techniques might reflect the low economic power of commenters, which in turn caused worry. However, as negative emotions related to money were not an exclusive characteristic of SDES, they will be discussed thoroughly in section 16.4.

Random comments with a score of 1 and 2 in Sadness suggest that this emotion was related to lack of enough information and professionals. It was discussed in section 12.2 that the SDES video network tends to be more egalitarian. A revision of videos analysed through semantic and sentiment methods clarified that several experts did not self-identify in the videos' content, which causes uncertainty about their credentials. This partly caused negative sentiment among Spanish YouTube viewers, probably worsened by the *perception of virtual colonialism*.

Videos lack of fit to local contexts elicited negative emotions as well. Some clusters that contained comparisons between Spanish speakers' context and others were Cluster 7 *Chile-US* and 8 *Latinamericans*. Cluster 8 was a slight predictor for feelings and both clusters had a slight correlation with Sadness. Random comments with a score of 1 and 2 in Sadness showed a link between this emotion and lack of context. The predominance of content from WEIRD countries was discussed in section 12.2. Stakeholders discussing WEIRD technologies and practices might have aided the negative sentiment towards lack of local context.

This context goes beyond the political and economic dimensions, as climate and living systems availability differ considerably according to region.

Many commenters mentioned that although some videos are good, they do not have a high number of views. Therefore, the power of *virtual colonialism* can be noted once again in the scarcity of adequate content for Spanish speakers, and whenever good content is available, the accessibility to it is highly compromised due to YouTube's algorithm prioritization of sensationalist, negative content.

17.2. 5. Religion as a Positive Aspect

Words related to religion (*God*, *bless* and *blessings*) were included in cluster 1 *Jorge*, which was the highest predictor for feelings in Spanish. Also, this cluster was correlated with Positive Polarity, Joy and Trust.

Islam, Shintoism and other religions have expressed respect and protection for nature in clearer terms than Catholic Christianism, which is the predominant religion in Spanish speaking countries. The Catholic version of the Bible has been interpreted as giving nature an utilitarian role. In contrast, Pope Francesco (2015) released an encyclic titled *Laudato Si*, which brings attention to the science behind ecological degradation, the responsibility of humans and an ecological view that includes a spiritual dimension. The encyclic was well received among progressive Catholics (e.g. González Alonso, 2017).

Although around 80% of the videos' comments were done after *Laudato Si*'s release, the integration of religion in conversations about sustainable design was subtler. *Blessings* is considered an expression of goodwill that fosters the sense of community. Originally used by religious practitioners, such expressions have become common in the Spanish language. Their presence in the comments revised for the present study suggest kind communication.

17.2. 6. Ecophilia and Ecophobia with a Spanish Style

Although not as numerous as in English, there were positive terms connected to natural elements and plants. This reflects the animism (belief that natural elements are alive) of religions practiced by the many indigenous groups in Latin America. In particular, the Aztecs in Mexico's valley, the Mayas in the southern tropical lands of Yucatan and the Incas in the Peruvian plateau were successful populations thanks to their harmonious relationship with the living planet (Vargas Hernández, 2004). Animism and spiritism are still important in Bolivia, Chile, Guatemala and Venezuela, covering from 1.4 to 25% of the total population (Helen Kellogg Institute for International Studies, 2009). Moreover, the recognition of nature as subject of rights in the Constitution of Ecuador in 2008 and the Universal Declaration of Rights of Mother Earth in Bolivia connect animism to a political framework.

Despite the aggressive imposition and promotion of Catholic Christianism in the Latin American region, a postmodern syncretism, where people can choose their religion or believe aspects of several religions at the same time, is connected to animism (De la Torre & Martin, 2016). However, contrary to beliefs that religion is irrational, and hence not useful for scientific or technological inquiry, the case of sustainable design in Spanish speaking countries highlights how subtle religious elements aid a more integral view of the world, where the designer recognizes the value of nature.

On the other hand, the most related cluster to natural elements (in this case materials) was cluster 13 *Earth*. This cluster was slightly correlated with Negative polarity, Fear and Sadness. Top comments in terms of Fear and Sadness revealed a connection to "dirty" nature. Other top comments in terms of Anger and Disgust also revealed this connection.

Ecophobia has been mostly explored in kids in Spanish (e.g. Burgess & Mayer Smith, 2011; Strife, 2012), in similar terms to the English case. Although ecophobia is interlinked with the loss of indigenous knowledge and living systems in the global South (Bora, 2016b), it was not found often in the comments sample. Part of the reason might be that designers tend to have favourable views of technology. It could also be assumed that someone familiar with the countryside would be less likely to view nature as dirty, judging by the multiple SDES videos filmed in ecovillages and other rural locations.

Disgust is a way of dealing with several threats, including contamination, pathogens, human mortality, and the moral domain; while many cultures conceive social order as vertical with demons and animals in the bottom (Rozin & Haidt, 2013). It is noted again how disgust towards nature has roots in a separation of humans from other beings and the living planet, which points once more to a loss of indigenous knowledge in Spanish speaking countries. Nevertheless, it would be relevant to study ecophobia more thoroughly on Spanish speaking adults together with ecoambiguity, which is more evident in the Spanish sample due to the perception of nature as materials.

17.3 Characteristics And Advantages Of Sustainable Design

The two previous sections of the discussion mostly dealt with differences found in the comments. The next two sections will focus more in similarities.

17.3. 1. A Problem-solving Interdisciplinary Activity

The existence of a cluster about problem solving in SDEN (although is not among the top clusters) and the inclusion of problem-solving related words in the Spanish cluster 14 *Earth* point to a perception of design as a problem-solving interdisciplinary activity.

Table 42. Words Contained in the Cluster about Problem Solving

Word	Word Freq.
Problem	749
Solution	239
Solve	102
Perhaps	86

Multiple stakeholders were mentioned among the most frequent words. However, the networks point to more isolation in the case of designers than architects. This result might have been influenced by the number of videos related to architecture in both networks and by the better diffusion of Sustainability standards in this field. Nevertheless, there is some indication that this result was not platform dependent.

Papanek (1971) himself criticized how each type of designer worked isolated from others. In relationship with a network visualization by Börner (2010) where there was a missing "dark field" which would potentially connect all other knowledge fields, Boehnert (2018) suggested that the dark field is design. Therefore, not much has been improved since the seventies. This persistent lack of connection is a call for designers to get more involved with other stakeholders in the design process and to diffuse sustainability standards related to more neglected fields like packaging, multimedia, web, etc. In order to achieve such objective, the creation and strengthen of design unions similar to those in existence for architects and engineers would be desirable, besides a thorough reform of academic programs.

17.3. 2. Positive Sentiment associated to Humble Role Models and Women

In SDEN, the word cluster 4 *She* and positive polarity had a significant correlation, while clusters 7 *He* and 13 *Jacque* had significant correlations with joy. The terms in cluster 4 *She* slightly predicted sentiment scores. In SDES, cluster 1 *Jorge* and positive polarity had a significant correlation, the cluster 12 *Information* (associated with a woman architect) had a slight significant correlation, and cluster 14 *Lucia* had a significant correlation with joy. Also, the words in cluster 1 *Jorge* predicted sentiment scores in over 25% of the cases.

It was mentioned in the literature review that there is a lack of role models in sustainable design. One of the reasons why network science was employed in the present study is because it aids the detection of "celebrities" or "influencers" who are relevant for specific groups. Although Elon Musk (part of the Cluster *He*) is not a role model in terms of how he treats people (Wong, 2018; Chau, 2018), he was an attractive designer for many video viewers because of his nerdy attitude, workaholic stance and his awkwardness when he talks in public. In other words, although he can be considered a successful businessman with strong ties to engineering, he gets sympathy because he is a flawed human being and the type of guy who was picked up in his early years. His body language and voice tone when he explains his projects were very similar to his counterpart in SDES, the architect Jorge Belanko. The difference between these role models is that, while Musk tours us around his factories, enterprises and projects, Belanko builds a house in most of the videos where he appears. He does not call himself an architect, and his behaviour does not differ from the builders who help him.

Regarding women in SDEN, although there were role models like Amanda Burden, Elora Hardy, Janine Benyus and Leyla Acaroglu, besides numerous female commenters throughout the videos, most of the times they were called *she* or *her*. Representation in professions traditionally dominated by men is very important, especially taking on account that sustainable design includes a gender equality dimension. The implication of not using women designers' names frequently is that they can not be detected by search engines, making their videos harder to find than those that portray men. Moreover, given that semantic analysis often discards pronouns, it is difficult to compare these results outside the scope of the present study. Thus, future research should analyse pronouns to identify and describe the role of women in social networks as commenters, content creators and leaders.

SDES had more active female representation in designers like Gemma Gómez and Lucía Garzón. One of them participated in the video comments actively, with a professional but warm tone. In sum, role models in sustainable design related videos tended to show less traditional characteristics attributed to men (violent, self-confident, arrogant, competitive, etc.).

Although the first study indicated very low correlations and prediction percentages related to type of speaker, the present study confirmed that some speakers could elicit positive feelings among YouTube commenters and inspire them, aiding the popularity of the videos where they appear. Therefore, rather than lacking role models, such role models have remained part of a niche group of designers which has limited public visibility.

17.3. 3. YouTube Commenters keen to Complexity

6 of 39 topics in SDEN and 18 of 26 topics in SDES had more focus on design, while the rest of topics were related to economic, political, historical, biospheric and knowledge. Also, Top 10 comments in terms of Trust (which was the most frequent emotion according to the sentiment category test) showed a systems' thinking perspective and a wide range of topics included in the conversations.

These results reflect the systemic design perspective that has been disseminated in the latest decades, which seeks to create complex industrial systems based/inspired on ecosystems (Barbero & Toso, 2010), influenced by human-centred design and service design (Ceschin & Gaziulusoy, 2018).

17.3. 4. Long Comments and Trust

Given that mental processes to persuade can involve thoughtful and long explanations (based on Petty et al., 2009), results suggest that long comments stimulated knowledge interchange associated with trust. This could imply more potential for collaboration between commenters. Moreover, despite of technological limitations in non-WEIRD countries, SDES comments also tended to be long and explanatory.

17.4. Barriers And Criticism Towards Sustainable Design

17.4. 1. Ignorance, Ineffective Design and Ugliness

In SDEN, cluster 2 *Ignorance* was the most related to this term, which slightly predicted sentiment scores. This cluster was also highly correlated with negative polarity, anger, disgust and fear. 10 random comments with top scores in disgust and fear revealed diverse scenarios where ignorance elicited negativity, while 10 random comments with anger score equal to 1 revealed this sentiment was associated again with ignorance. Furthermore, 10 random comments with a combination of the most frequent emotions (trust, anticipation, joy and fear) revealed negativity towards ignorance as well. In SDES, 10 top comments in terms of disgust revealed once more a connection with ignorance.

Taking on account that complexity and knowledge interchange was associated with trust, it makes sense that ignorance elicited negative sentiment. This can also affect the acceptance of sustainable design, as ineffective design elicited negative emotions. In SDEN, cluster 11 *Information* slightly predicted sentiment scores. Cluster 8 *Design* and negative polarity were slightly correlated.

Cluster 11 *Information* and negative polarity, disgust and fear were correlated as well. Top comments showing fear revealed worry about ineffective design. 10 random comments showing anger, disgust and fear scores equal to one revealed again that such emotions were connected to ineffective design and insufficient information to design in a proper way. Anger was particularly focused to energy storage in random comments, while disgust also was linked to "ugly" design.

In SDES, top comments in terms of anger, disgust, fear and sadness were related to ineffective design as well. Moreover, 10 random comments with average scores of 1 and 2 in sadness were also connected to ineffective design. Further, anger was connected to "ugly" design.

These results confirm the findings of Niederer et al. (2016) regarding the avoidance of adoption of sustainable design due to its lack of effectiveness, while semantic and sentiment analyses uncovered additional information on the subjective effects of ineffective sustainable design. However, there is some bias on the type of design viewed as ineffective. In revising comments related to energy, batteries and anger, it was found that they were mostly located in a video about Elon Musk, which was among the most commented in the sample. This video was released around a month after a newspaper article pointed out a flaw in a Tesla's car battery (Brother, 2013). The comments do not address this information directly, but there was a lot of discussion about batteries materials, design and function.

Otherwise, perceived ugliness of design might be related to a lack of self-identification by the video viewers. Considering that perceived beauty implies an ability to communicate a positive aspect of self-identity and that it is not strongly affected by experience (Hassenzahl, 2004), this finding points to the need of highlighting characteristics of sustainable design that might appeal to viewers who do not identify with most of the positive values found in the present study.

Moreover, the relationship between ineffective design and information suggests a lack of alignment between stakeholders' objectives. This is particularly salient in humanitarian aid design, where it is advised to involve as many stakeholders in the design conceptualization and process as possible to make sure that objectives are clear, congruent and that the product/service will reach its final user (Fladvad Nielsen, 2018). However, in the case of SDEN, comments expressing fear and sadness (the second strongest relationship in the sentiment network) reflected acceptance for sustainable design. In both networks, the presence of sadness suggests an affective attachment to design, coped with proactive feedback.

17.4. 2. People and Society

There were several SDEN clusters with topics about people: clusters 1 *James*, 4 *She*, 5 *People* and 9 *American*. They predicted emotions considerably, while cluster 5 *People* had the highest score in the regression analysis. With the exception of cluster 4 *She*, word clusters related to people had greater significant correlations with negative polarity. Clusters 1, 5 and 9 also had significant correlations with disgust and fear. Top comments in terms of disgust and fear, and 10 random comments with disgust scores equal to one revealed a connection between these emotions and society again. In SDES, top comments in terms of anger and fear revealed a link to YouTube users.

Fear of the societal structure and humans can be broken down in several factors. Rendueles (2017) mentions that caregiving should be the material basis of our social bonds. However, in our current world and particularly in big cities, people have the opposite perception. WEIRD communities also have a stronger tendency for individualism than non-WEIRD ones, so a disconnection between individuals is perceived. Moreover, individualism was expressed in the comments through the fear of losing freedom and autonomy, which elicits a preference to have a wide variety of choices (Tonkinwise, 2018). Therefore, individualism underpins consumerism, which goes against sustainable design principles.

Another problem some commenters detected was fear or resistance to change. This issue is largely due to the perception of change as a loss. That is why for conservatives or people who resist change, it is advisable to focus in the part of the past that all stakeholders want to preserve, and in a mentality shift from winners vs. losers to all winners. As negotiation processes will always entail risks, strategies for risk management would also be desirable.

Beck (2009) conceptualizes risk as human decisions and futures that require commitment to responsibility and accountability, being manufactured uncertainties (externalizable, collectively imposed and individually unavoidable uncertainties) one of its components. In other words, when decisions taken at an individual level are done by many individuals, they can become group level decisions that are difficult to visualize in detail. Likewise, when a decision-making process does not correspond to a conventional stakeholder, new negotiation processes have to emerge. Thus, their outcomes become difficult to control.

In such cases, a careful consideration of location and culture will aid the negotiation process. Transparency and openness should also be the norm to ensure that all the involved actors know enough of the issue at hand, and that their points of view are taken on account. Regarding such aspects, the SDES video network showed less negative feelings towards people and society because Spanish speaking countries tend to be more collectivistic. It should be reminded that a similar pattern of communication, with exchange of information and personal contacts, was found in videos from Africa and South Asia in SDEN.

On the other hand, the type of social/human interaction that generated considerable negative feelings in SDES was towards other YouTube commenters. Given the considerable amount of polite language in the Spanish network, this might indicate a fear to offend other users, which could in turn degrade the reputation of the commenter and undermine collective trust. This phenomenon and its impact on the degree of truthfulness in online communication has not been studied in detail, remaining as an opportunity area for online emotion researchers.

It is important to detect hints of cooperation and healthy communication in social networks to aid the restoration of social solidarity offline. Part of the reason why there were negative emotions toward people and society in the comments is because we tend to project our fears and anger onto other people (Brown and Macy, 2014). In the case of designers, "creativity is blocked when we resist images, ideas or feelings that might trigger moral pain" (Brown and Macy, 2014). Therefore, it is imperative to foster empathy, constructive criticism and proactive ways of dealing with pain in the design process.

17.4. 3. The Economic-political System

Two clusters in SDEN included words related to economy: cluster 12 *Money* and Cluster 14 *System*. These clusters predicted sentiment scores considerably, and both were significantly correlated with negative polarity and disgust. Top 10 comments in terms of disgust showed a connection with money and the economy. In SDES, cluster 2 *System* and cluster 4 *Economy* contained words about this topic. These clusters predicted sentiment scores considerably too. Cluster 2 was significantly correlated with negative polarity, while both clusters were correlated with anger and sadness. Top comments in terms of anger and sadness, and random 10 comments with a score of one in terms of sadness also revealed a link to money. Moreover, top comments in terms of anger also revealed negativity linked to governmental institutions.

One factor eliciting negative sentiment towards the economic system is that sustainable design is perceived as expensive and elitist. Taking on account that the concept of sustainable design was promoted by developed countries in North America and Europe in the beginning, YouTube users from developing countries tend to feel excluded from such products and the life styles associated with them, as can be noted in comparisons between developing and developed countries found in clusters 7 *Chile-US* and 9 *Latinamericans* of SDES.

Nevertheless, the most important factor that affects the perception of sustainable design as expensive is related to the production cycle and the desire of oligopolies to keep it as usual. Industrial production employs mechanized methods, low-cost human labour located in highly deregulated places and consumes a wide variety of resources, including non-renewable energy stocks. Some resources are not easy to quantify in economic terms. Therefore, the final product price tends to be artificially low for the consumer.

Such tendencies started to change when renewable energy sources like sun and wind became affordable competitors for non-renewable resources. It is true that some corporations (e.g. Shell in the networks of the present study) are aware of the limits of non-renewable energy stocks and thus are actively researching and investing in alternatives. Some are doing this only as a façade, giving room for greenwashing. Regardless of the outcomes, there are actors with an interest in keeping their overlarge profit and their privileges intact.

One example is the Koch family and other American enterprise leaders who base their world view in public choice theory. Developed by Buchanan (1984), a Nobel Laurate, political theorist and economist, the basis of public choice theory is that people are selfish by nature and will do everything it takes to keep their jobs, life style, etc. In consequence, people cannot be trusted. This has been disproved by evolutionary theory (Axelrod & Hamilton, 1981), which emphasizes cooperation and diversity as the base of prosperity and sustainability of life. Nonetheless, the most important factor behind the diffusion of public choice theory is money.

Charles Koch organized wealthy donors to fund all sorts of university research, non-profit organizations and government related initiatives (MacLean, 2017). Donella Meadows (2018) distinguishes several levels to transform a system, being the power to transcend paradigms (or mindsets) the most impactful. The Koch family worked for decades to change paradigms. The rights of the wealthy few are protected while the many are prevented from exercising countervailing power, government is shrunken, there is no social security, worker or public-health protections, and all public property is privatized according to McLean (Parry, 2017). Other objectives of Buchanan and his scholarly followers were to oppose feminism, environmentalism and to dismantle public education because it fosters community values (Parramore, 2018).

The consequences (particularly impactful in the U.S. and UK, which are the countries where most of sustainable design videos were uploaded from) became more than evident when a white supremacist was elected as President of the U.S. in the 2016 election, and the Brexit referendum majoritarian vote was to leave the European Union. The intersection between individualism, racism, resistance to change and systemic barriers for sustainable design becomes thus, clearer.

These are only some of the most striking examples where public choice theory has been used to radically change reality. We could consider that non-WEIRD countries are relatively safe from such ideologies because of the strength of their community values, reflected in the comments analysed in the present study. However, there is evidence that Buchanan was behind Pinochet's dictatorial take-over of Chile, concretely through Constitutional changes to avoid spending in public services (Parramore, 2018).

In reality, there are pockets of strong communities in WEIRD countries and weak communities in non-WEIRD countries, particularly in urban centres. Castells (2010) called these pockets "The Fourth World… made up of multiple black holes of social exclusion throughout the planet". This is why designers related to the architecture area have to be careful with urban design, and prioritize rural design and humanitarian design.

Berkun (2018) argues that designers tend to believe they have the talent to improve what already exists, but that combined with immaturity, this prevents them to see (or simply ignore) the real structure and mechanisms of organizations; while their distaste for politics distances them from others political behaviours. Part of the problem is a perception of politics as overly difficult language contained in rhetoric and laws which are manipulated by powerful people for their benefit, to the extent of exerting intentional oppression and violence. This generates negative feelings, as could be appreciated in the comments analysed in the present study.

In fact, the act of making any decision which has consequences for others is politics. Every time a designer chooses to order their lunch from the transnational burger chain instead of walking five minutes to eat in a small stall attended by a local woman cooker, the designer is affecting other beings in several ways. Of course that every time a designer chooses to obey a client who wants an unnecessary packaging for their product, or works for a client who wants to create a potentially harmful service, the designer is being political.

It was already discussed in section 12.1 that design products and services can be hold politically and ethically accountable. Design involves power relations/dynamics that implement neoliberal political agendas, but design education still has to respond in an adequate way (Maze, 2018). The result of having so many unprepared designers in terms of politics is unemployment and underemployment. Policy design and design policy are also increasingly necessary. In other words, designers can not pose as innocent and remain bystanders if we truly want to keep designing. We are "always part of a construction of power and privilege" (Søndergaard, 2017).

The key to understanding politics is that designers have to analyse their own situation in depth. Politics is another way of solving problems which targets many elements (mostly people). However, as discussed in this section, designers tend to be isolated from other stakeholders. Thus, we have to analyse people in order to work together with them, share negotiation and cooperation strategies and ultimately, unionize to be able to make decisions in equal terms with other stakeholders who are presently more powerful. Recent examples from the U.S. include Google workers pushing back against military projects and sexual harassment (Tarnoff, 2018; Verge Staff, 2018); and Apple, Facebook, Google and

Microsoft workers against working for enablers of Immigration and Customs Enforcement (Frenkel, 2018).

The production methods of everyday products and services remains a mystery for most people, who feel disempowered to intervene in the system in any significant way. In those regards, designers provide a unique opportunity to change paradigms, with their insights on production mechanisms and methodologies. Although incomplete, the knowledge a designer possesses could avert much of the damage industries do, if paired with correct assistance of other experts from different disciplines. Therefore, a designer should learn to manage their negative feelings towards the political-economic system and reach to others.

17.5 The Limitations Of Video Social Networking Sites

The great number of videos with projects and prototypes particularly from non-WEIRD countries represent an opportunity for reverse innovation that, due to the structure of YouTube's algorithm, fails to reach potentially interested viewers, provoking negative feelings. Moreover, YouTube has deactivated the mentions function that enabled commenters to tag specific users, and rolled out the option of private comments in videos, further limiting communication particularly in the case of non-WEIRD countries. This is not an exclusive limitation of YouTube, but it highlights once more how decision making in social media companies does not take on account most of the users in the world.

The first part of the present study was not capable of finding strong predictors for videos popularity. However, findings of the second study confirmed suspicions about the importance of type of speaker for both networks, and of the importance of location in Spanish speaking countries. This might imply that QAP tests were not sensible enough to detect relevant factors.

There are two possible reasons for the technique's weakness: the first one is that the effects of the variables could be strong only for a few very popular videos; and the second one is that statistics for network analysis are still underdeveloped. A re-run of the QAP analysis in the samples of popular videos did not show significant results. Therefore, the importance of other analysis techniques like semantic, sentiment, psychological network estimation and qualitative study of texts to understand social networks has been highlighted.

17.6. Positive Vs. Negative Emotions In The Adoption Of Sustainable Design

Thelwall et al. (2011) provided empirical evidence that popular events were associated with increase in negative sentiment of Twitter texts. The present study showed clear increase, but in positive sentiment, particularly in SDES. This might be partly because sustainable design is a niche topic, while YouTube's viral videos usually depict sensationalist content (Lewis & McCormick, 2018) that elicits negative emotions.

The implication is that YouTube is not only an entertainment website full of disinformation or superficial trends. At a small world level, it can be useful for the interchange of information and the generation of ideas. This also highlights the generation of positive emotions due to intellectual labour, creative expression and a healthy community environment, which also suggests that viewers might react favourably to prosocial and humanized content despite that many designers do not tend to be keen to social interactions.

Regarding negative emotions, Hine et al (2016) divided audiences according to their beliefs of climate change in dismissive, believers and unsure, finding that advertisements which included strong negative emotive content or provided specific adaptation advise increased adaptation intentions in the three segments; and that omitting any climate change mention with emphasis on local impacts increased adaptation intentions in dismissive audiences. This study implies that highlighting direct threats to the self or other humans who matter to the audience might be effective for engaging them.

Unfortunately, it is not entirely clear to which extent a strong emotional content would be able to activate an audience regardless of a mismatch on the level of understanding of the complexity of the problem when complexity is so relevant to solve the problem. Former studies suggest that emotionality should be capable of activating the audience, but in a designers' scenario where objectivity is required, the level of impact emotionality would have in adopting or reaffirming sustainable design related behaviours is still unclear.

17.7. Biophilia, Ecophobia And The Ambiguity In Between

It is believed that people who are concerned about the living planet will try to follow a green lifestyle. Yet, it was not very clear to which extent designers concerned about the environment incorporate green practices in their work. What becomes clearer through the present study is how some designers who watched YouTube videos about sustainable design feel a connection to the environment and plants, particularly to animals in SDEN and to other natural elements in SDES. Commenters are aware of their existence and importance. This becomes contradictory (ecoambiguous) when design implies destruction of one or more forms of life for the sake of another (usually human). For example, when a new paper box is designed, many trees are sacrificed to create a product that might not be necessary. In another level, companies can lie about the content or procedures to develop their products (what is called "Greenwashing").

In other instances, pollution and ethical issues are exported, creating shadow ecologies. For example, the creation of new electronic products usually involves low concentrations of toxic substances, scarce metals and earth elements that are often associated to civil conflict in developing countries (Ryen et al., 2018). When the product is discarded, the electronic waste is usually shipped from a developed country to a developing country, where low wage labourers recover the different components and materials in workplaces where there are no safety measures, much less legislation to protect their rights (Ryen et al., 2018).

Some software tools like Autocad and Solidworks have incorporated Life Cycle Assessment tools to evaluate the environmental impact of materials used in a potential product. However, the only way to decrease uncertainty in design processes related to ethical and political issues is to communicate with people who know how products are ensembled, transported, where materials are extracted and how the products are pulled apart and disposed of. More knowledge connecting law and labour rights acquired from other stakeholders at global and local levels would also be desirable. Again, engaging with other people and politics understood as decision making are essential.

Negative feelings related to the living planet are collectively called ecophobia. In the case of SDEN, ecophobia manifested more frequently as fear for natural disasters, while it manifested occasionally as a view of nature as dirty in SDES. While in the case of English ecophobia stemmed from uncertainty, in Spanish it stemmed from disgust. Foust and Murphy (2009) distinguish between two apocalyptical rhetorics, where natural disasters are either fated or can be influenced by humans. By revising the English comments once more, it is noted that most of the instances that mention destructive nature tend to link it to human influence, which reflects critical self-awareness and a call to action.

Regarding disgust connected to ecophobia and morality, conservatives (who tend to be less keen to adopt pro-environmental behaviours) also have a predisposition to feel disgust (Inbar et al., 2009). As videos in both languages had very low scores in terms of disgust, it could be assumed that commenters tended to be liberal, and further, that they would be more willing to adopt pro-environmental behaviours (see Rozin et al., 2015). However, it should be noted that pro-environmental intentions do not necessarily translate in real behaviours. For designers, staying away from nature due to ecophobia implies leaving an entire knowledge and creativity library untapped. Moreover, lack of fear towards nature can aid a professional image in front of clients who do not have experience with design (Rogal & Sanchez, 2018).

Ecophobia was unusual in both networks. Instead, eco ambiguous activities, attitudes and feelings were frequently present because most of the comments were long and tended to analyse the designs from several angles, providing pros and cons. This result is relevant because the design object and process should not be viewed as black or white. A 100% eco-friendly product or service is not feasible, but designers have to find motivation to strive towards designing better products and services anyway. We should remember that too much reasoning polarizes pro-environmental policy decisions and thus inhibits proactive behaviours (Hart & Nisbet, 2012).

17.8. What Was Missing From The Video Networks?

A few crucial elements were rarely mentioned in the videos and their related comments. In terms of nature inspired frameworks, biomimicry involved a tiny fraction of the videos. Biomimicry is still a niche area of engineering and was rarely mentioned in connection to other areas of design. Also, more radical methods for sustainable design like transition design (focused in widening the scope of designed futures) and elimination design were not mentioned.

The United Nations included one Sustainable Development Goal about Sustainable Cities because it is estimated that most of the world population will live in cities in the near future. Although there were several videos about urban design in this study, the definition of what is a city in them is rather limited. According to Davis (2006), 6% of the city population in developed countries lived in slums, but in the case of developing countries, it was 78.2%.

Taking on account that a wide production of crafts provides from slums, which lack the most basic services but are still a part of cities, there is a high untapped potential of creativity. Therefore, urban designers and architects should come together with other designers, experts and citizens to redefine, re-localize and thoroughly plan cities. Otherwise, the real impact of sustainable urban design products and initiatives will only reach a small and already privileged percentage of the population, while many sustainable solutions generated in the periphery might pass unnoticed.

Although mentions of renewable energy resources were frequent in both languages, more in-depth conversations about oil were absent. Given that oil is a raw material for most plastics, and that they are important components of many products and packaging, designers should understand oil origins and applications to offer sustainable alternatives.

18. CONCLUSIONS

In the present study, semantic, sentiment analysis and psychological network estimations were useful to explore the context of attitudes, emotions and graphical representations in comments related to videos about sustainable design in two languages. A considerable number of words and graphical representations were included in the analysis and two types of sentiment scores were employed. According to objectives stated in section 13, the findings were as follows:

1. The English network expressed theory orientation, war aversion, negative views on religion, ecophilia related to animals, ecophobia related to fear, and environmental privilege. In contrast, the Spanish network showed project orientation, individual female representation, Do It Yourself attitude, concern

about lack of monetary, knowledge and professional resources, lack of fit to local contexts, religion as a positive (communal) aspect, ecophilia related to natural elements, and some ecophobia related to disgust.

2. Comments in both languages expressed a problem-solving interdisciplinary mindset, humble role models and women, ecophilia towards plants and acceptance of complexity. Overall results confirmed lack of effectiveness as an important barrier for sustainable design (Niedderer et al., 2016), but did not provide evidence for lack of time. Instead, negativity towards ignorance, people, society, and the economic-political system were frequent barriers.

2.2 Relationships between designers and other stakeholders were described, confirming the need to connect design practitioners to other sectors of society. The role of a supportive community, trust and interchange of information was noted, particularly in Spanish comments and English comments related to videos uploaded by non-WEIRD countries.

3 Emotional (people and money) and non-emotional (design and engineering) topics in the comments related to videos about sustainable design were uncovered. Overall, nature related topics also elicited positive emotions.

3.2 It was found that in the case of English, graphical representations did not change sentiment scores, while the opposite was true in Spanish. According to expected results, weak positivity predominated in the comments.

Most recent research about Social Networking Sites has highlighted negative aspects of such services. In contrast, the present study emphasizes the importance of small sized internet communities that are capable of fostering dialogue about complex topics in an open and creative oriented manner. However, how much creativity and an open mind contributes to the healthy interchange of information in this scenario is still an open question. It is also unknown how much the positive intentions expressed in the comments reflect real proactive behaviours among designers. What became clearer was the interplay of objectivity (mostly linked to design and engineering) and positive emotions towards other humans, living beings and knowledge connected to design.

How religious/spiritual aspects operate related to sustainable design in online comments was explored for the first time in Spanish speaking countries. Environmental conservation terms like ecophilia, ecophobia and ecoambiguity were applied to design, describing how they operate for English and Spanish speakers; and more specifically, how they operate in Spanish speaking countries related comments on Video Networking Sites for the first time. Also, public choice theory was employed to discuss barriers for sustainable design and the emotions elicited as consequence, highlighting the need of social sciences in creativity related fields.

Identifying human values and meanings while considering the contexts shaping their preferences, "is essential for redirecting them and us toward a socially and culturally acceptable path toward sustainability" (Leong & Lee, 2018). The present study also emphasizes the importance of including data from non-WEIRD and underrepresented countries, especially taking on account the environmental privilege present in SDEN. These power dynamics can be uncovered only if there is more comparison between diverse countries perspectives. Moreover, although there was some presence of East-Asian countries like China, Japan, Korea and Taiwan among English videos and comments, it would be relevant to conduct more in-depth analysis targeting such countries languages.

In sum, the present study developed a lexicon of up to date vocabulary related to sustainable design in English and Spanish. This lexicon includes information about attitudes, behaviours and sentiments that can be used as keywords to develop a system of video recommendations similar to YouTube, focused on studying sustainable design in context.

CHAPTER V: DEVELOPMENT AND TESTING OF A RECOMMENDATION SYSTEM BASED ON A SUSTAINABLE DESIGN APPROACH.

"Our challenge is to develop systems that meet our needs and that are regenerative to us and nature, that take and give at the same time."

-Leyla Acaroglu (2018)

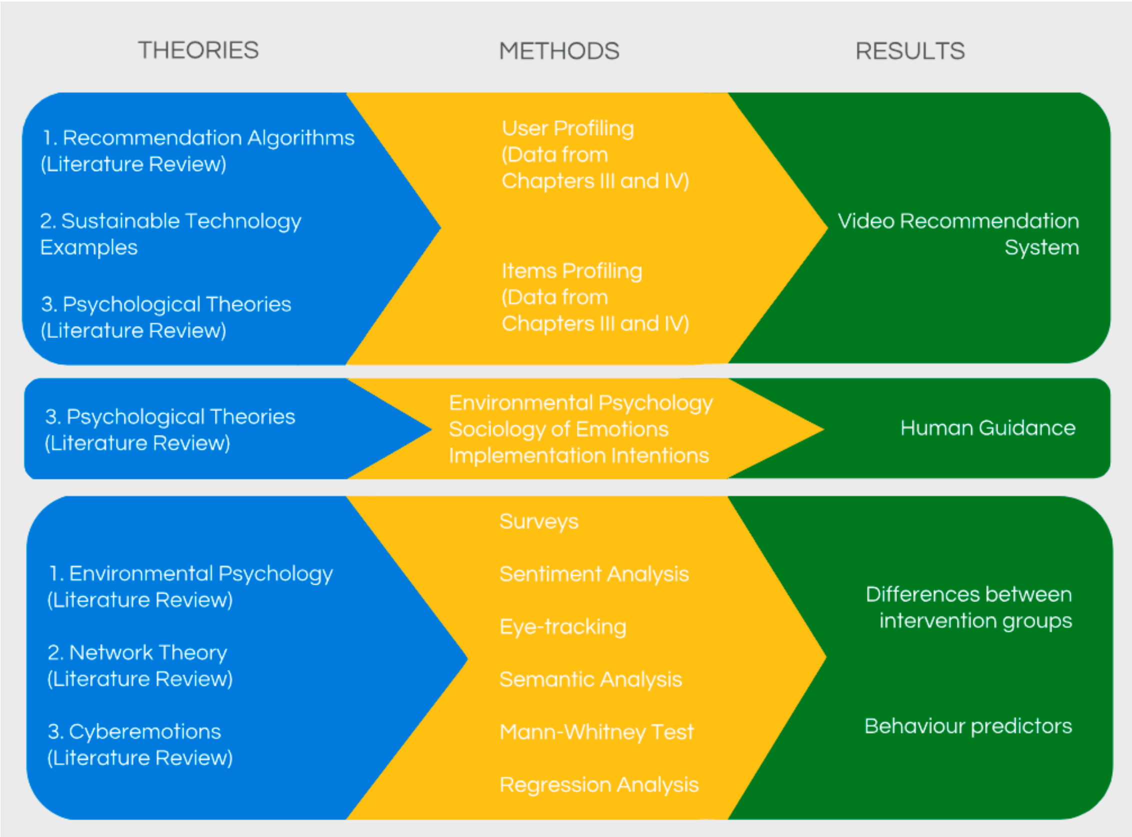
19 OBJECTIVES

Given that former chapters findings are limited regarding the effectiveness of videos as educative materials, sustainable design behaviours of designers in the real world and lack information about Asian countries, this chapter aims to answer the following questions:

1. How can videos foster pro-environmental behaviours in the design process?
2. Would a personalized video recommendation system have better results in terms of interest related to sustainable design than YouTube?
3. Could a personalized video recommendation system fair better paired with human guidance?
4. Which attitudes, behaviours and sentiments are related to sustainable design among Asians?

To answer these questions, the following workflow will be implemented:

Figure. 68.Workflow for the Development of the Educational Intervention



20 METHODS

20.1 A Sustainable Design Approach For Recommendation Systems

The scarce adoption of sustainability in web design and its related engineering implies that there are few working examples of how a recommendation system embodying sustainable design principles could be. However, the design process should target designers' way of thinking and working to modify the impact we have on the world (Ito, 2016). Considering individual, social, structural and ecological issues related to interaction with technology explored in previous sections, several strategies based on Ito (2017), Acaroglu (2018) and Ehn et al. (2018) were examined. These designers propose to conceptualize technology as extended, adaptative and regenerative intelligence that also aids psychological restoration. In sum, technology harmoniously integrated with a physical reality.

Examples of embodied technologies that display some of the desired characteristics include the Lightphone (Light, 2018), a phone only to make phone calls; a core memory made by hand where the focus shifts from technology to its behaviour (Rosner et al., 2018); and the cocreation of a technological embroidering development (Pérez Bustos & Márquez, 2016). Among software, Calmy Writer, Twitter Demetricator and Facebook Social Fixer reduce features to help users focus on specific tasks.

Emotions treatment in the system vary according to the classification of users in interested, indecisive and uninterested in the topic. Negative emotions towards people and nature were managed through environmental psychology and sociology of emotions, based on sections 3 and 4 of the literature review.

Some of the users practiced implementation intentions. The educational intervention borrowed from Stroh's (2015) "system stories" which shift perception in three ways: a) From seeing just a part of the system to see more of it; b) from hoping for change in others to see how they can change themselves; and c) from focusing on individual events to understanding and redesigning deeper levels of the system.

20.2 Design Concept Of The Educational Intervention

Table 43 shows a summary of issues with the adoption of sustainable design in English and Spanish, found in section 16.

Table 43. Summary of Barriers for Sustainable Design Behaviours

English Comments	Both	Spanish Comments
	Environmental	
- Natural disasters		- Dirty nature
	Systemic	
- Religion	- Money	
- War	- Politics/Government	
	Hierarchical	
- Loss of autonomy		
- Loss of freedom		

Psycho-Social		
- Racism	- Ignorance	- Incompetence
- Resistance to change	- People	
Formal		
- Infeasible	- Ineffectiveness	- Conventional methods
	- Information (quality and quantity)	- Lack of Local Context
	- Ugliness	

To manage these problems, several counterflows are summarized in Table 44. The H in parenthesis means that a human can provide the counterflow, while a V in parenthesis means that videos can provide it. Counterflows involving community strengthening and political organization are not contemplated in this version of the educational intervention. However, it is important to mention them, as they could be implemented in future versions.

Table 44. Summary of Counterflows against Barriers for Sustainable Design Behaviours

English	Both	Spanish
Environmental		
- Manage Fear of Loss (H)		- Visual Interaction with Nature (V)
Systemic		
- Human Interaction (H)	- Human Interaction (H)	
- Political Organization	- Political Organization	
Hierarchical		
- Human Interaction (H)		
- Community Strengthe-ning		
Psycho-Social		
- Diversification of Information Sources (H, V)	- High Quality Information (H, V)	- High Quality Information (H, V)
- Human Interaction (H)	- Human Interaction (H)	
- Personalization (H, V)		

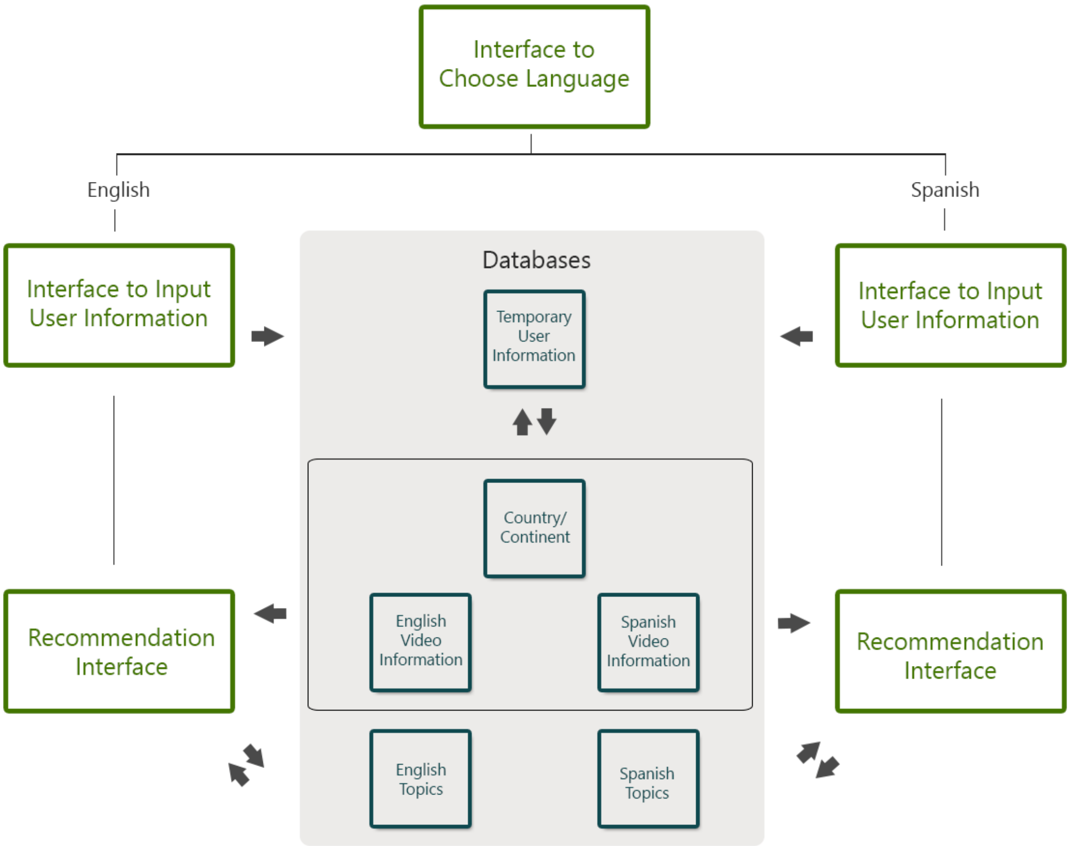
Formal		
- High Quality Information (H, V)	- High Quality Information (H, V)	- High Quality Information (H, V)
	- Personalization (H, V)	- Focus on Local Context (H, V)

In terms of racism, as empathy and alienation predict its variances (Nicol & Rounding, 2013), and there is evidence for at least short-term effects on racism mitigation through cross-cultural training programs (Durey, 2010), the diversification of information sources (showing different cultures) and human contact were considered. Moreover, according to the literature review, implementation intentions have effect on reducing prejudice, which is also a previous step for racism manifestation.

20.3 Recommendation System Functions

The system consists of an application to watch videos with a reduction of distractions like ads or viral videos. The application does not store user information permanently to enhance anonymity and flexibility of recommendations. It aims to be a calculator that employs the user's objective characteristics and their sentiment towards the topic to optimize recommendations. Because the system should also offer varied content to avoid eco chambers and to increase contact with other cultures, some degree of randomization in the items was preferred. As videos are called through the YouTube API, they still receive views and are not manipulated in a way that infringes the social network policies. Figure 69 describes the system, and sample code can be consulted in Annex 29.

Figure 69. Structure of Video Recommendation System



For items profiling, the top sustainable design videos databases in English and Spanish (156 and 142 items respectively) including their related information was stored in the application. This information consisted on the variables shown in Table 45:

Table 45. Variables Contained in Video Databases

Source	Variable Name	Description
Data about videos obtained for Chapter III	Video id	Link to the YouTube video.
	Label	Title of the video.
	Country – Continent	Countries of the YouTube channel and/or disclosed countries of speakers classified according to continent.
	Design area	Type of design shown in the video.
	Speaker area	Type of speaker and/or designer shown in the video.

Data on comments obtained for Chapter IV	Sentiment polarity	Average of the sum of SentiStrength negative and positive polarity scores.
	Sentiment emotionality	Average of the sum of SentiStrength negative and positive polarity scores transformed to measure non-emotional and emotional comments.
	Sentiment category	Average of the Syuzhet scores for anger, anti-cipation, disgust, fear, joy, sadness and trust.
	Topic scores	Maximum fuzzy similarity of topics found in videos comments, calculated with Excel Fuzzy Lookup ad-on.

The emotionality of comments was calculated using the formula described in Chapter 4, section 16.1.5. Average of emotionality was considered as a proxy for interest in the video because emotional content can be arousing, so it is more likely to provoke a reaction in the user. As for maximum fuzzy similarity, fuzzy logic represents the real world based on a degree of membership for elements into a given set. Thus, videos were classified into many overlapping topics.

Input (user profiling) is user occupation, expertise field, country, sentiment and interest related to sustainable design. Output is a list of videos recommended for the average user with the same characteristics (except for sentiment). Figure 70 shows the welcoming interface. The user(s) or moderator (e.g. a teacher) can select the desired language. The system activates the corresponding database and rescales the polarity and emotionality scores to use them in the next step.

Figure 70. Welcoming Interface of the Video Recommendation System.

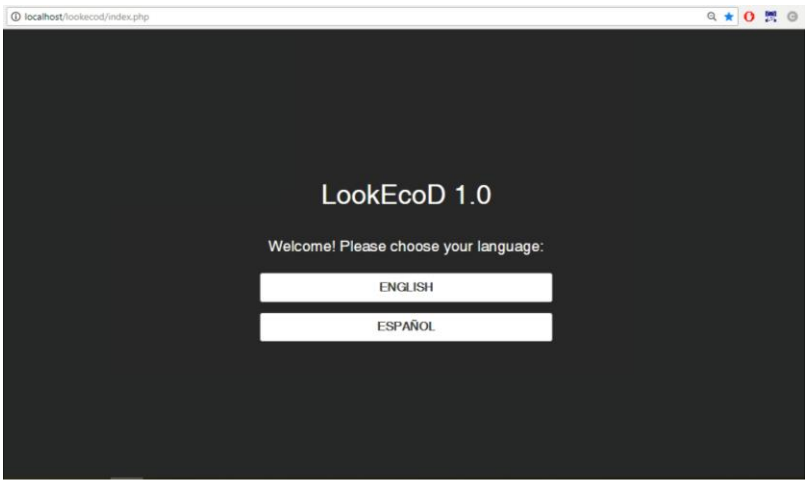
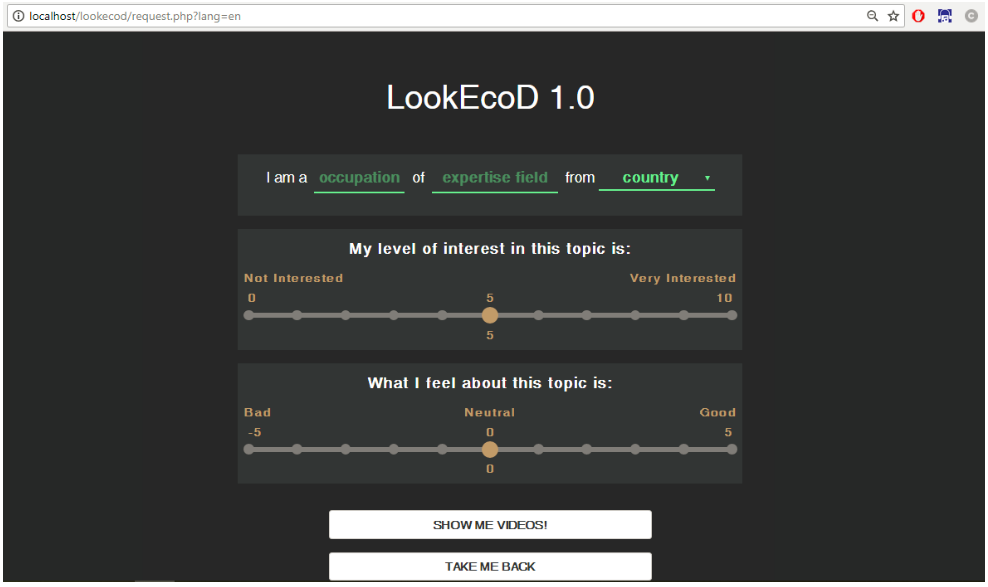


Figure 71 presents the data input interface. A user can select occupation (speaker area), expertise field (design area), country, interest (emotionality) related to sustainable design and sentiment (polarity) about sustainable design.

Figure 71. Data Input Interface of the Video Recommendation System.



Next, the system defines maximum video list size as 20 and classifies the user according to the scheme shown in Table 46:

Table 46. Classification of Users.

User Type	Interest (Emotionality)	Feelings (Polarity)
Interested	6 to 10	-5 to 5
Indecisive	0 to 5	1 to 5
Uninterested	0 to 5	-5 to 0

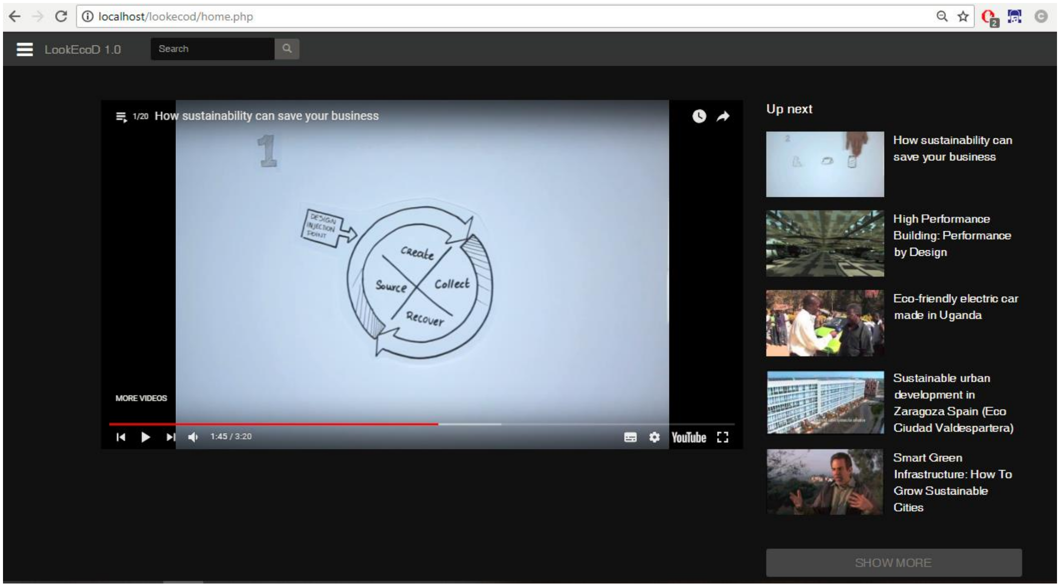
The system also assigns a sequence start for Syuzhet scores, shown in bold in Table 47. Given that sadness is related to love, interested users might be able to tolerate this emotion. Because anticipation related comments tended to evaluate pros and cons of sustainable design in an almost neutral way, this emotion was the starting point for indecisive users. Moreover, because urgent and concrete arguments can activate uninterested users according to the literature review, fear was chosen as their starting emotion.

Table 47. Sequence of Video Sentiment Scores According to User Classification.

User Type	Joy	Trust	Anticipation	Sadness	Disgust	Anger	Fear
Interested	1	2	3	**4**	5	6	7
Indecisive	1	2	**3**	4	5	6	7
Uninterested	1	2	3	4	5	6	**7**

Videos listing is done according to similarity based on Euclidean distance, divided in two processes. The first video is selected based on the sentiment scores sequence and most recent uploading year. The other videos are selected according to most recent uploading year, speaker area, design area, continent and emotionality. After the calculations, the system shows the interface in Figure 72. The first video is played in the left, while the thumbnails in the right show 5 of the 20 videos. A button with the legend *Show More* displays the rest of the thumbnails when clicked.

Figure 72. Watching Interface of the Video Recommendation System.



When the user clicks on a second video, the system handles the request depending on the time spent watching the first video, as the user might have gotten bored or annoyed. According to Table 48, Interested and Undecisive users would be exposed to more negative emotions, while Uninterested users would be exposed to more positive emotions. Because Spanish speakers tend to click faster than English speakers, time is different for both system versions. Video listing is based on the variables: most recent uploading year, occupation/type of speaker, expertise field/type of design shown, country/continent, sentiment score sequence and emotionality.

Table 48. Handling of New Video Request.

For English Interested_User and Indecisive_User if watch_time 10≤seconds go forward with sentiment scores sequence else go backward with sentiment scores sequence	For Spanish Interested_User and Indecisive_User if watch_time 7≤seconds go forward with sentiment scores sequence else go backward with sentiment scores sequence
For English Uninterested_User if watch_time 10≤seconds jump to Sadness and then to Trust, else go backward with sentiment scores sequence	For Spanish Uninterested_User if watch_time 7≤seconds jump to Sadness and then to Trust, else go backward with sentiment scores sequence

If a user searches by keywords using the search bar located in the upper left side of the interface, video listing is the same as described above, adding the topic variable. When a user quits the program, they exit the browser and their information is not stored.

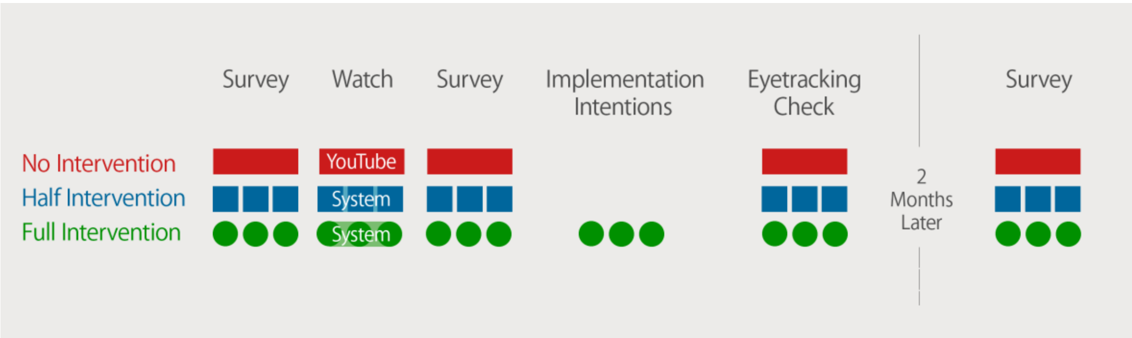
20.4 System Evaluation Methods

Recommendation systems are usually tested through precision and recall, which have been discussed in Section 14.3.1. However, number of videos in YouTube is constantly changing, making impossible to know the real number of ideal recommendations that exist. Therefore, only the first 20 items in 4 search cases were taken on account (for interested, indecisive and uninterested types of user in the recommendation system, and one more search in YouTube). As result, precision and accuracy scores were the same. Speaker area, design area and continent were considered to calculate precision and recall, based on whether the videos matched a student of architecture located in seven continents.

20.5 Educational Intervention Evaluation Methods And Adjustments

For the pre-experiment, 3 English and 3 Spanish speakers were divided in three groups (Figure 73). They participated in the evaluation individually. The control group searched and watched sustainable design related videos in YouTube, while the half and full intervention groups used the recommendation system. The full intervention group discussed more in depth with the researcher to practice implementation intentions according to their skills, interests and obstacles to practice sustainable design. Participants also answered a survey before and after watching videos, and they were sent one more survey 2 months later by e-mail, to measure their basic knowledge, practice, feelings and interest on sustainable design. The surveys content, which was delivered through SurveyMonkey, is available in Annexes 30 to 37. Watching time was around 10 minutes, while each survey took around 5 minutes to answer. Overall, no intervention and half intervention groups took around 30 minutes to complete the activities, while the full intervention group took around an hour.

Figure 73. Work-flow of the Evaluation of the Educational Intervention.



The gaze of a participant was tracked with Tobii Pro while they were watching/searching videos, which aided the quantification of the viewers' objects of interest, and the understanding of their viewing/searching patterns. The researcher showed the recorded eye gaze to the participant and discussed it to clarify any misconception or further discuss a particular object of interest in line with Hedman (2014).

The only adjustment on the experimental procedure was in the Spanish video database, which had 55.6% of architecture videos. Given that the original sample of Spanish YouTube videos contained 49% of architecture videos, some items were taken out from the database, reducing the total number of videos from 142 to 126. 26 more subjects participated in the evaluation of the educational intervention as described above, employing eye-tracking in 19 cases.

20.6 Data Analysis

Each individual participant's data was assigned an alphanumerical code. Answer items of the surveys where the viewers describe their feelings with their own words were analysed with SentiStrenght software (Thelwall, 2017). Objects of interest recorded with eye-tracking were classified based on types of environmental values according to De Groot and Steg (2008), regardless of whether these objects were real, 2D, 3D, etc. A new category for designers (Design Object) was introduced as well:

Table 49. Classification of Objects of Interest

Type	Examples
Design Object	City, theatre's interior, car, logotype, bar chart, etc.
Human	Man, woman, child, etc.
Living Being	Animal, plant, minerals and other materials found in nature.
Environment	Sky, landscape.
Money	Coins, money box, etc.

The variables considered for statistical analysis were:

- Demographic variables: age, occupation, design area, gender, continent, language, intervention group.
- Survey 1 variables: previous knowledge of sustainable design, sustainable design definition length, number of sustainable design projects, sentiment related to sustainable design (Likert scale), sentiment positive polarity, sentiment negative polarity, sentiment polarity sum, emotionality, interest.
- Eye tracking variables (if available): number of watched videos, total watching time, watching time according to types of objects of interest, average of watching time according to types of objects of interest, total fixation time, fixation time according to types of objects of interest and average of fixation time according to types of objects of interest.

- Survey 2 variables: sustainable design definition length, sentiment related to their viewing experience (Likert scale), sentiment positive polarity, sentiment negative polarity, sentiment polarity sum, emotionality, interest in sustainable design.
- Survey 3 variables: sustainable design definition length, number of projects after the intervention, sentiment related to sustainable design (Likert scale), sentiment positive polarity, sentiment negative polarity, sentiment polarity sum, emotionality, interest.

Numerical and categorical data was compared according to treatment groups, language and nationality in SPSS to find out a) the effects of half intervention and full intervention; and b) the effects for English speakers, Spanish speakers and Asians. Regression on number of projects and interest two months later were also conducted to find predictors among the variables.

Because not all participants gaze was recorded, and because definition length is not a very comprehensive measure of knowledge, semantic networks were calculated with ConText (Diesner, 2014) and drawn with Gephi (Bastian et al., 2009) to visualize and compare definitions of sustainable design in the three data collection points. Moreover, a comparison between words used by participants to define sustainable design and their feelings towards it, and the sustainable design lexicons was performed to find out: a) how representative the participants were of the average sustainable design YouTube audience; and b) which words were unique among Asian participants.

21 RESULTS

21.1 System Evaluation

Table 50 shows 4 search cases: YouTube, and the recommendation system under three types of users (interested, indecisive and uninterested). Average precision and recall in English were lower for the system in locations of developed countries. However, content from more continents was included among the recommended items, which was an intended effect to confront viewers with situations in different countries, in line with bio speculative design. In the Spanish version, average precision and recall were higher, with content from unclear locations considerably less present among recommended items. This addresses the users need of more local content discussed in section 16.2.

Table 50. Precision and Recall of the Video Recommendation System.

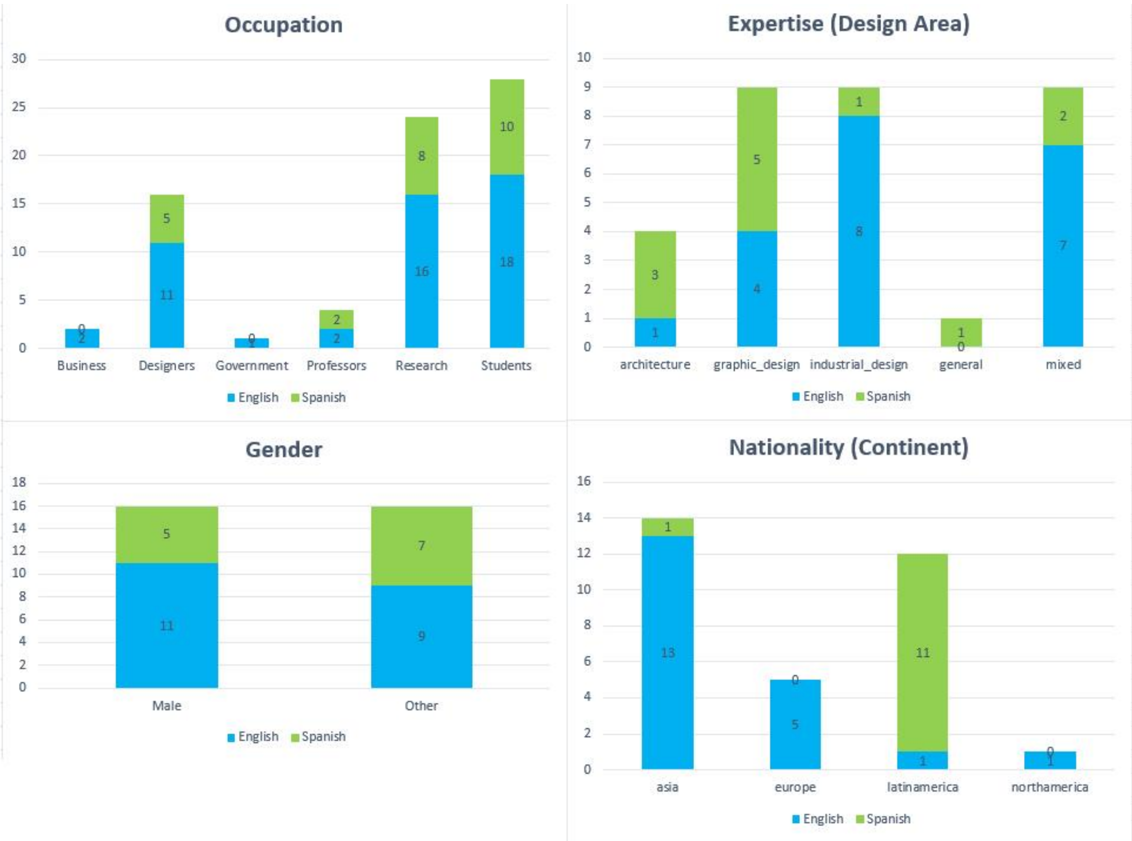
ENGLISH	YT Prec	YT Rec	Sys Int Prec	Sys Int Rec	Sys Ind Prec	Sys Ind Rec	Sys Uni Prec	Sys Uni Rec
N. America student	**0.075**	**0.075**	0	0	0	0	0	0
N. America architecture	0.375	0.375	**0.45**	**0.45**	0.375	0.375	0.375	0.375
N. America continent	0.375	0.375	**0.5**	**0.5**	**0.45**	**0.45**	**0.45**	**0.45**
N. America AVERAGE	0.275	0.275	**0.316**	**0.316**	0.275	0.275	0.275	0.275
Europe student	**0.075**	**0.075**	0	0	0	0	0	0
Europe architecture	0.375	0.375	**0.45**	**0.45**	0.375	0.375	0.375	0.375
Europe continent	**0.35**	**0.35**	0.15	0.15	0.125	0.125	0.125	0.125
Europe AVERAGE	**0.266**	**0.266**	0.2	0.2	0.166	0.166	0.166	0.166
Oceania student	**0.075**	**0.075**	0	0	0	0	0	0
Oceania architecture	0.375	0.375	**0.45**	**0.45**	0.375	0.375	0.375	0.375
Oceania continent	0	0	0	0	**0.1**	**0.1**	**0.1**	**0.1**
Oceania AVERAGE	0.15	0.15	0.15	0.15	**0.158**	**0.158**	**0.158**	**0.158**
South Asia student	**0.075**	**0.075**	0	0	0	0	0	0
South Asia Architecture	0.375	0.375	**0.45**	**0.45**	0.375	0.375	0.375	0.375
South Asia Continent	0	0	**0.1**	**0.1**	**0.05**	**0.05**	**0.05**	**0.05**

South Asia AVERAGE	0.15	0.15	**0.183**	**0.183**	0.141	0.141	0.141	0.141
Asia student	**0.075**	**0.075**	0	0	0	0	0	0
Asia architecture	0.375	0.375	**0.45**	**0.45**	0.375	0.375	0.375	0.375
Asia continent	0	0	**0.025**	**0.025**	**0.05**	**0.05**	**0.05**	**0.05**
Asia AVERAGE	0.15	0.15	**0.158**	**0.158**	0.141	0.141	0.141	0.141
Africa student	**0.075**	**0.075**	0	0	0	0	0	0
Africa architecture	0.375	0.375	**0.45**	**0.45**	0.375	0.375	0.375	0.375
Africa continent	0	0	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**	**0.05**
Africa AVERAGE	0.15	0.15	**0.166**	**0.166**	0.141	0.141	0.141	0.141
SPANISH	YT Prec	YT Rec	Sys Int Prec	Sys Int Rec	Sys Ind Prec	Sys Ind Rec	Sys Uni Prec	Sys Uni Rec
Europe Student	**0.175**	**0.175**	0.125	0.125	0.05	0.05	0.05	0.05
Europe architecture	0.025	0.025	**0.35**	**0.35**	**0.6**	**0.6**	**0.6**	**0.6**
Europe continent	0.266	0.266	**0.375**	**0.375**	0.15	0.15	0.15	0.15
Europe AVERAGE	0.155	0.155	**0.283**	**0.283**	**0.266**	**0.266**	**0.266**	**0.266**
L. America student	**0.175**	**0.175**	0.125	0.125	0.05	0.05	0.05	0.05
L. America architecture	0.025	0.025	**0.35**	**0.35**	**0.6**	**0.6**	**0.6**	**0.6**
L. America continent	0.341	0.341	**0.55**	**0.55**	**0.65**	**0.65**	**0.65**	**0.65**
L. America AVERAGE	0.18	0.18	**0.341**	**0.341**	**0.433**	**0.433**	**0.433**	**0.433**

21.2. Descriptive Statistics Of Participants

Participants self-identified only one type of occupation in the surveys. However, interviews during the evaluations revealed other parallel or recently abandoned occupations. Figure 74 clarifies that: a) most of the participants were research students, although half of them also mentioned to have professional experience; b) most of the participants came from Graphic Design, Industrial Design and Mixed (Engineering) backgrounds; and c) most of the participants were from Asian and Latin American countries.

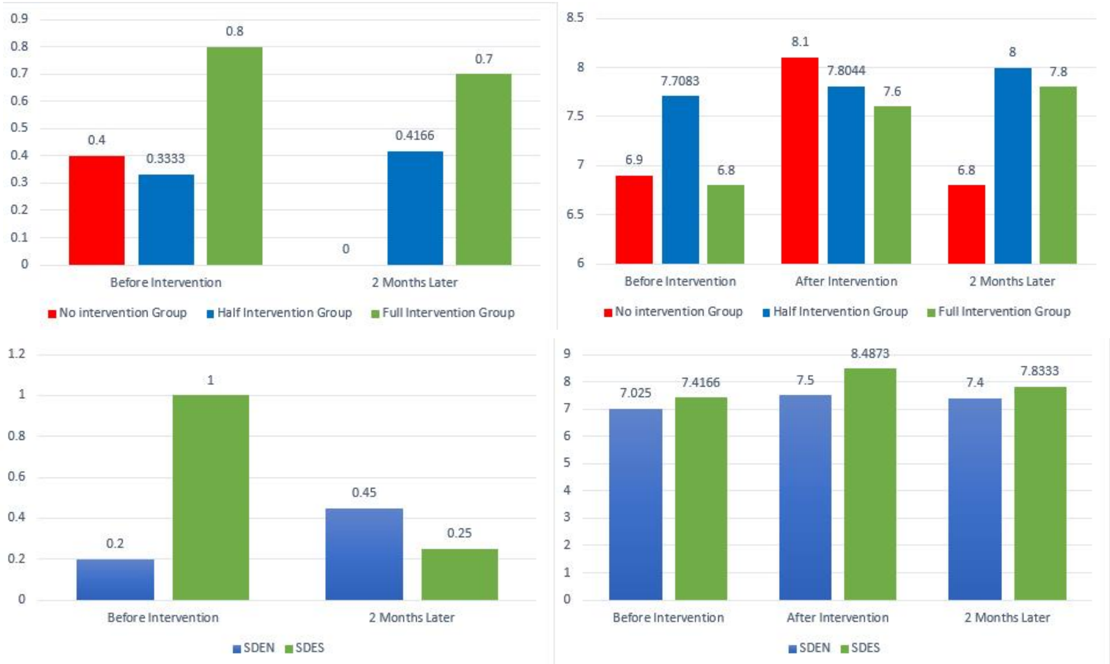
Figure 74. Occupation, Design Area, Gender and Nationality of 32 participants.



21.3 Interest Scores Vs. Sentiment Scores

There were no participants classified as indecisive in terms of interest. Interest in sustainable design was measured according to self-reported interest and number of projects done by the participants. Figure 75 shows averages of number of projects and interest in the y axes. While participants who used the recommendation system had an increase in interest and kept doing sustainable design projects despite of the holiday period in school, participants who used YouTube had considerably lower interest scores both before and 2 months after the intervention, stopping to do sustainable design.

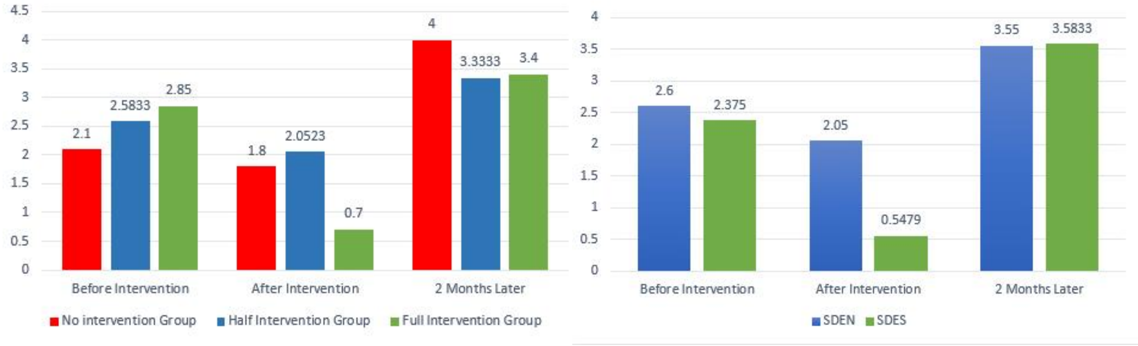
Figure 75. Average of Sustainable Design Projects (left) and Interest on Sustainable Design (right) according to Treatment Groups (N=10, 12, 10) and Language (N=20, 12).



It should be noted that only one English speaker and one Spanish speaker from the full intervention group refused to write the commitment that would complete the implementation intentions part. Moreover, projects average among English speakers was the highest after 2 months, although there were no significant differences in terms of interest according to language.

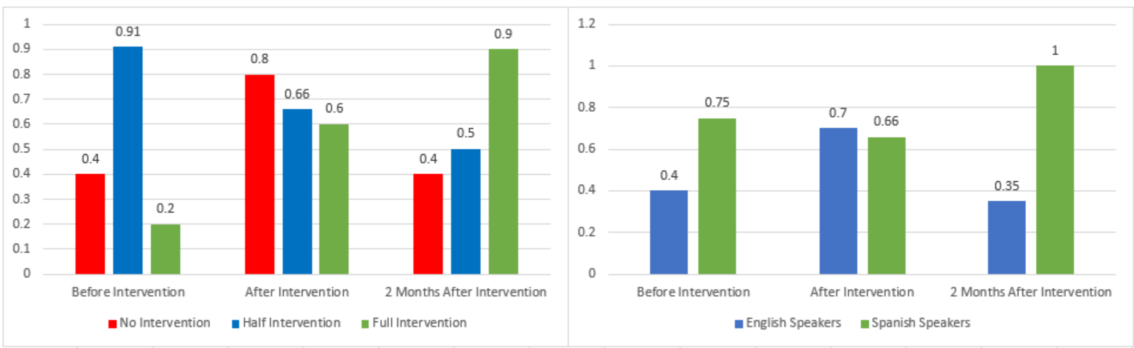
Self-reported sentiment scores are shown in Figure 76, where the y axes show averages. Although all participants felt less positive after the intervention, those who used YouTube reported the highest positive feelings 2 months later. Moreover, despite that after the intervention Spanish speakers felt less positive than English speakers, there were no significant differences in sentiment according to language 2 months later.

Figure 76. Self-reported Sentiment Scores
according to Treatment Groups (N=10, 12, 10) and Language (N=20, 12).



To analyse sentiments further, averages of SentiStrength scores were calculated for the feelings' description related to sustainable design. Figure 77 shows that YouTube users' positive feelings increased after the intervention while recommendation system users felt more negative. Two months later, polarity scores of full intervention participants were the highest. Overall, SentiStrength scores tended to be neutral in comparison to self-reported sentiment scores. In sum, a high level of interest and feelings which tend to be more positive than negative towards sustainable design apparently coincide with continuous practice. Despite that feelings of recommendation system users were less positive after the intervention, they tended to become more positive 2 months later, particularly among participants who were exposed to implementation intentions.

Figure 77. SentiStrength Polarity according to Treatment Groups (N=10, 12, 10)
and Language (N=20, 12).



Regarding languages, English speakers tended to have neutral sentiment before the intervention, more positive sentiment after the intervention and less positive sentiment two months later. The polarity scores of Spanish speakers were slightly less positive after the intervention and considerably more positive 2 months later, suggesting cultural differences in emotional dynamics.

21.4 Eye-Tracking

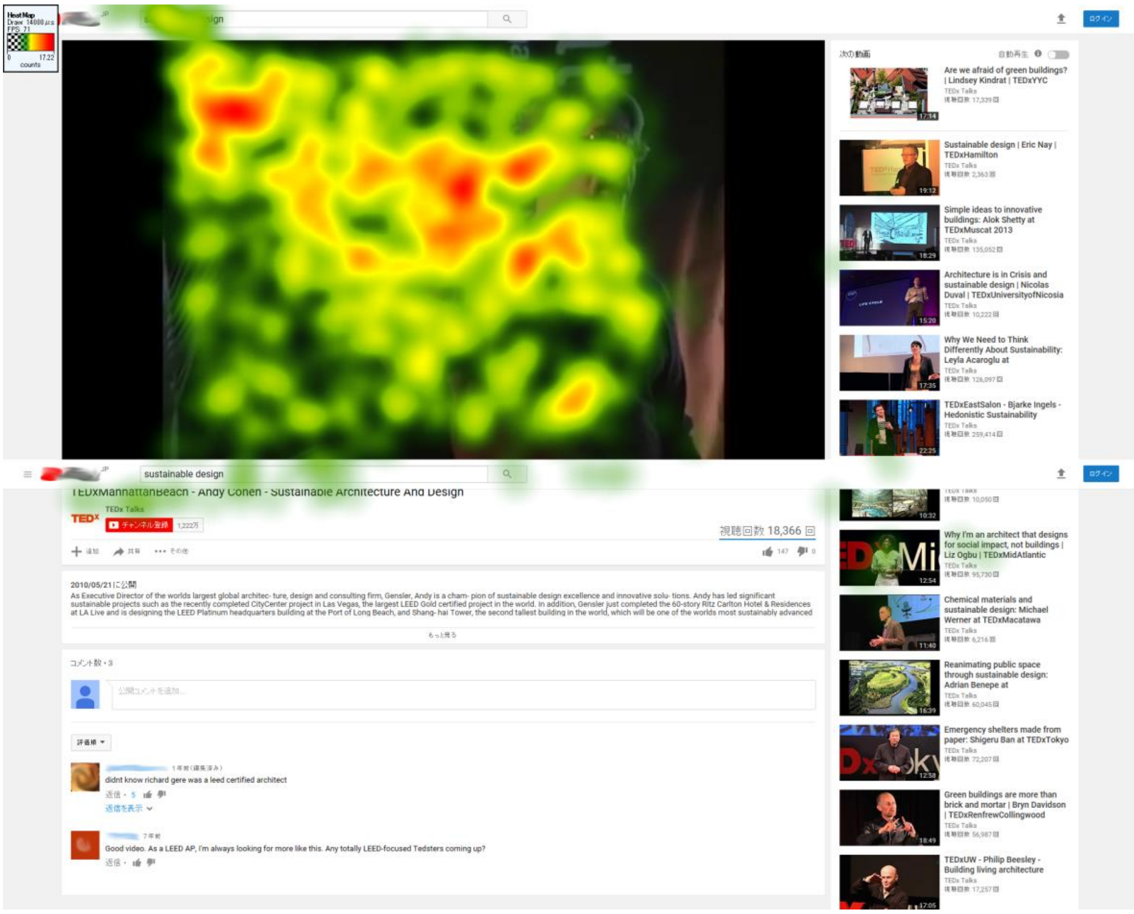
Eye-tracking data of one participant was discarded due to being registered for less than 50% of recording time. Descriptive statistics of 18 participants can be consulted in Table 51, where time was measured in milliseconds. Although YouTube users and recommendation system users watched roughly the same number of videos, the second group's total watching time was higher. They also watched design objects and environment for a longer time. Despite that Spanish speakers watched a bigger number of videos, the total video watching time was similar. English speakers tended to watch humans, living beings, environment and money more. Overall, design objects were the most watched in the videos, followed by humans, living beings, environment and money. The pattern of fixation time was similar across treatment groups and language.

Table 51. Descriptive Statistics of Eye-Tracking Data of 18 Participants

Group	Statistic	Number of Videos	Wat-ching Time	Design Object Watching Time	Human Watching Time	Living Being Watching Time	Environment Watching Time	Money Wat-ching Time	Fixation Time	Design Object Fixation Time	Human Fixation Time	Living Being Fixation Time	Environment Fixation Time	Money Fixation Time
YouTube Users	Mean	3.75	368743.5	116869.5	109929.3	52418.75	9067	2074.38	305686.38	107825.38	103536.88	10385.75	8843.00	2884.88
	Std. Dev.	3.955	116957.4	64355.54	90339.94	84869.04	6281.85	2476.69	99574.97	62366.46	78111.37	7426.45	5669.72	3542.06
Rec. Sys. Users	Mean	3.4	491028	207178.3	98933.9	12619.8	12944.2	320.2	441401.00	171876.10	91042.80	10962.60	12044.80	52.60
	Std. Dev.	2.271	74032.01	92261.62	47286.59	13317.19	17613.43	943.72	103539.34	84203.49	44012.89	8950.37	16205.60	166.33
N=8,10														
English Speakers	Mean	2.82	454242.1	151458	113411.3	44977.55	12953	1270.73	376921.73	129287.82	101568.36	12968.73	12026.91	1172.73
	Std. Dev.	1.537	100776.4	71431.52	74036.32	72681.64	16380.95	2273.63	107542.19	59612	66833.12	9269.43	14936.15	2583.97
Spanish Speakers	Mean	4.71	409080.7	191528.7	88749.86	7256.43	8499.29	831.29	387623.14	165599.71	88781.57	7150.86	8413.71	1529.29
	Std. Dev.	4.424	129907.9	118290.2	58274.05	4868.74	7820.16	1420.65	148102.71	106533.26	50779.94	4173.55	7609.65	3066.27
N=11,7														

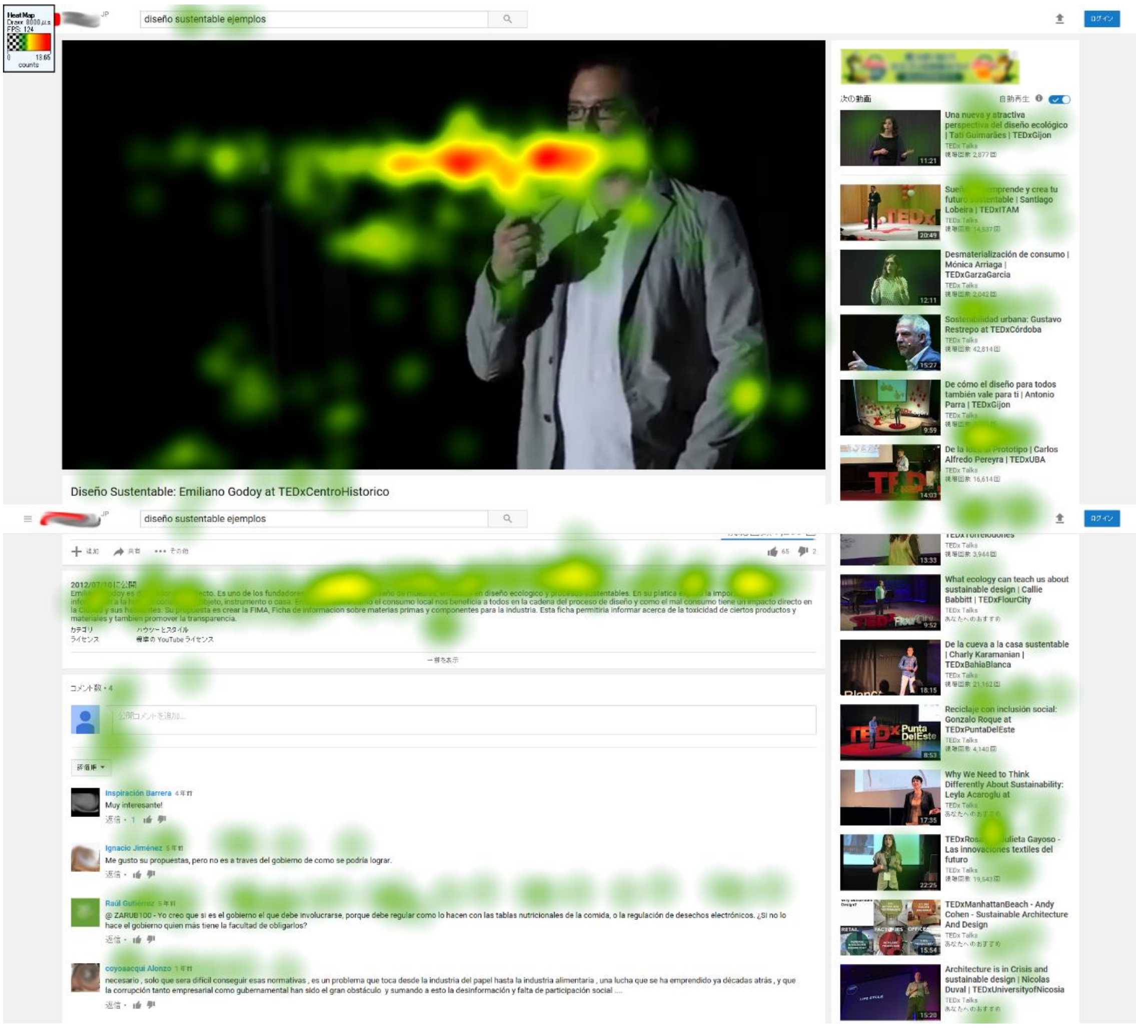
Figure 78 shows the heatmap of an English speaker while watching a sustainable design video from a YouTube TED channel. The redder the area, the more time the participant spent watching it. It was noted that English speakers tended to concentrate their attention in the videos.

Figure 78. Eye-Tracking Heatmap of an English Speaker using YouTube



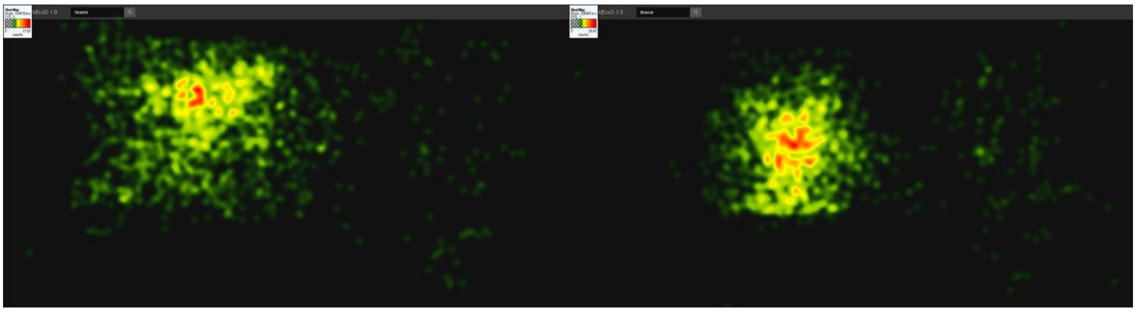
On the other hand, Figure 79 contains the heatmap of a Spanish speaker watching a video in a YouTube TED channel. As they were not so concentrated on the video, these participants tended to click in videos thumbnails more often and thus their number of watched videos was higher. English content was suggested among their recommendations (located in the right side of the image), so they often asked during the intervention if they could watch videos in English (they couldn't). It should be noted that content in other languages did not show up when English speakers used YouTube.

Figure 79. Eye-Tracking Heatmap of a Spanish Speaker using YouTube



Finally, Figure 80 shows an English speaker eye-tracking in the left and a Spanish speaker eye-tracking in the right while using the video recommendation system. Taking away distractions such as comments and video descriptions made Spanish speakers focus more on the playing video. English speakers watched information on suggested videos slightly more than in YouTube, probably because the content was visually more diverse.

Figure 80. Eye-Tracking Heatmap of 2 Participants using the Video Recommendation System

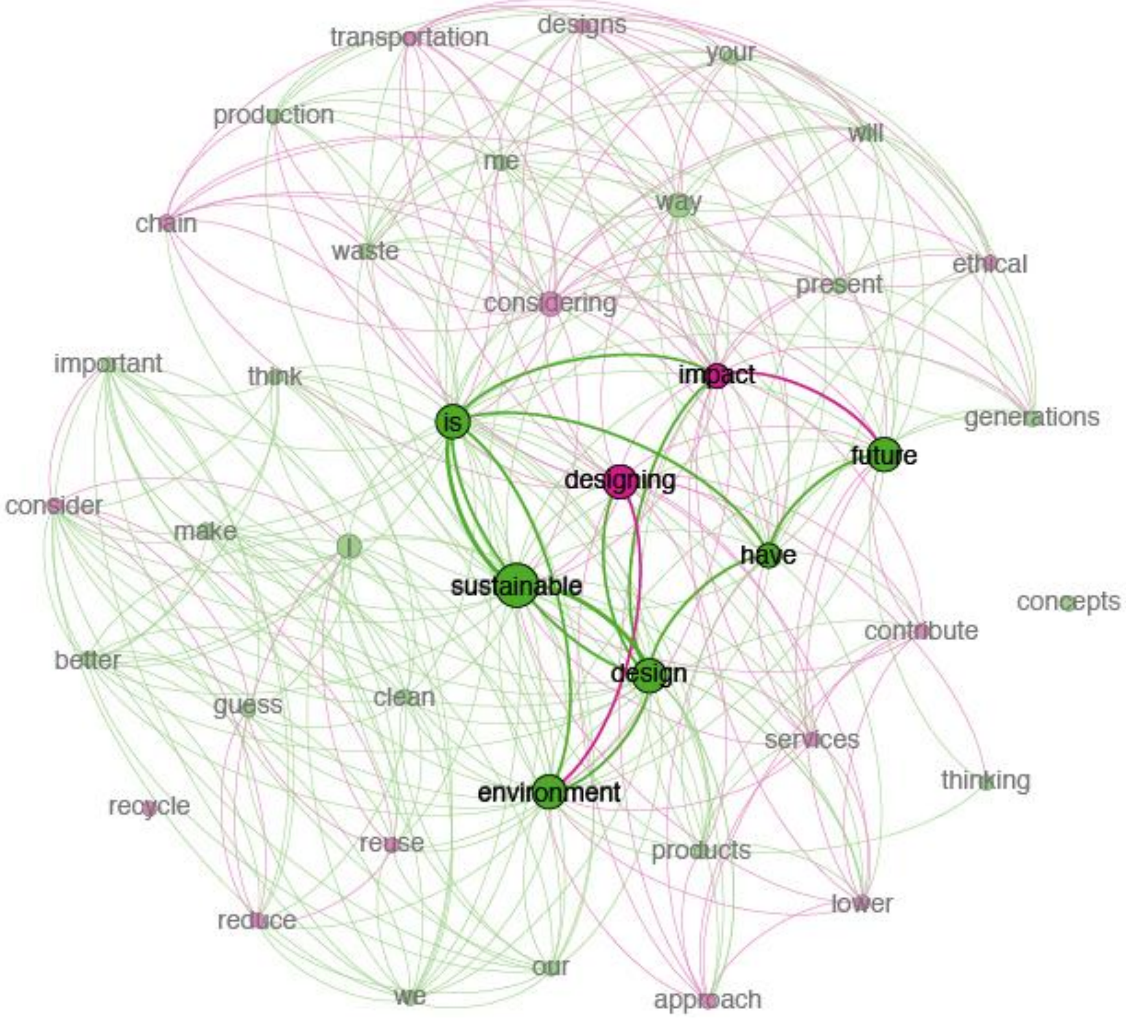


21.5 Semantic Networks Of Survey Answers

21.5.1 English Semantic Networks

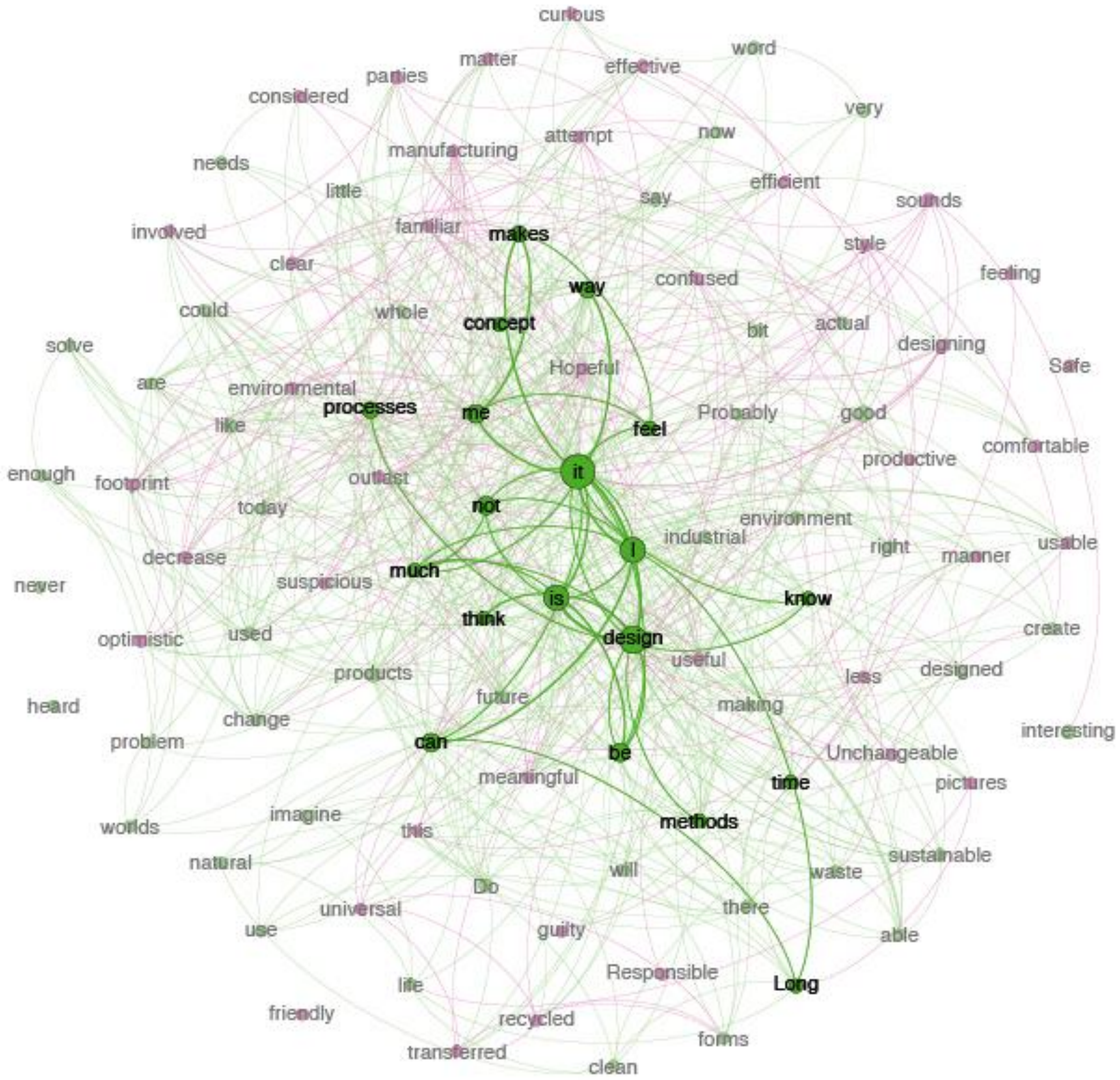
Survey answers on knowledge and feelings related to sustainable design were calculated as semantic relationships according to language. In the case of English, ConText was employed to draw one mode networks with aggregation per corpus, distance 14 by paragraph. Figure 81 shows words employed in 4 answers explaining what sustainable design is, with terms used only once and/or connected to other terms only once as watermark. Node size reflects word frequency, ties reflect which words were used together and green corresponds to words that were frequent in YouTube comments. The words *impact*, *future* and *environment* emerged, so it can be assumed that the definition of sustainable design for English speaking designers was focused in biospheric factors. Other terms included the industrial production cycle and old operational definitions like the three R's (*reduce*, *reuse*, *recycle*).

Figure 81. Semantic Network of English Speakers Definition of Sustainable Design Before the Intervention (N=41, Node size = 4 to 1, Tie thickness = 3 to 1)



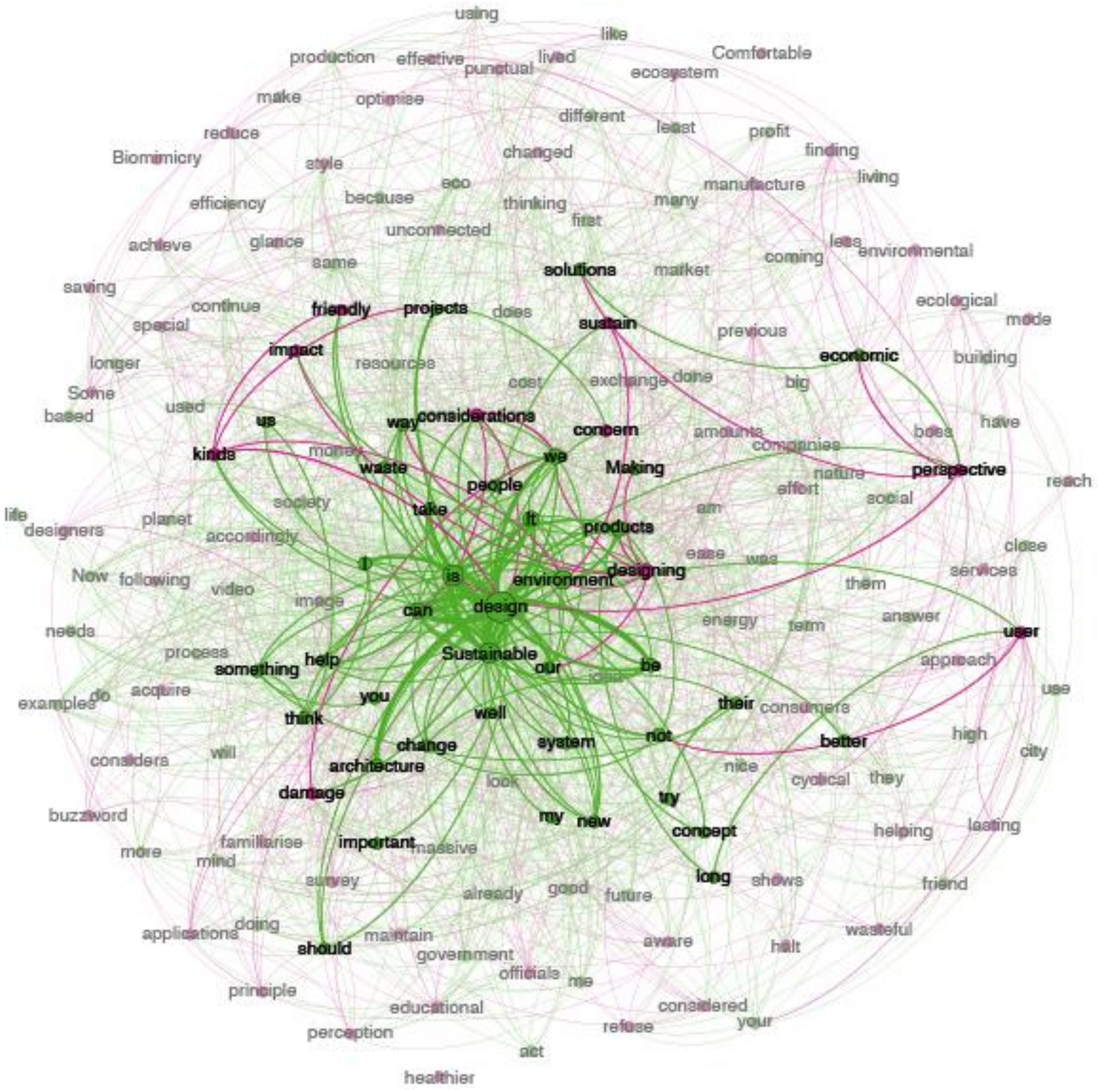
The 20 participants answers related to their feelings towards sustainable design are illustrated in Figure 82, where node size represents word frequency and ties show which words were used together. The consensus in English was that sustainable design was a cognitive related activity related to long periods of time, and that it did not make designers feel much. Terms used once included positive words like *comfortable*, *curious*, *optimistic*; and few negative words like *confused*, *suspicious* and *not enough*. The words *industrial manufacturing* were connected to *hope*, suggesting positive feelings towards a change in big scale production.

Figure 82. Semantic Network of English Speakers Feelings Towards Sustainable Design Before the Intervention (N=103, Node size = 11 to 1, Tie thickness = 4 to 1)



After watching videos, the 20 English speaking participants were able to define sustainable design. Figure 83 shows node size equivalent to word frequency and ties showing which terms were used together. A more integral definition with environmental, people and economic aspects emerged. Other words used once included several types of stakeholders and advanced techniques like biomimicry.

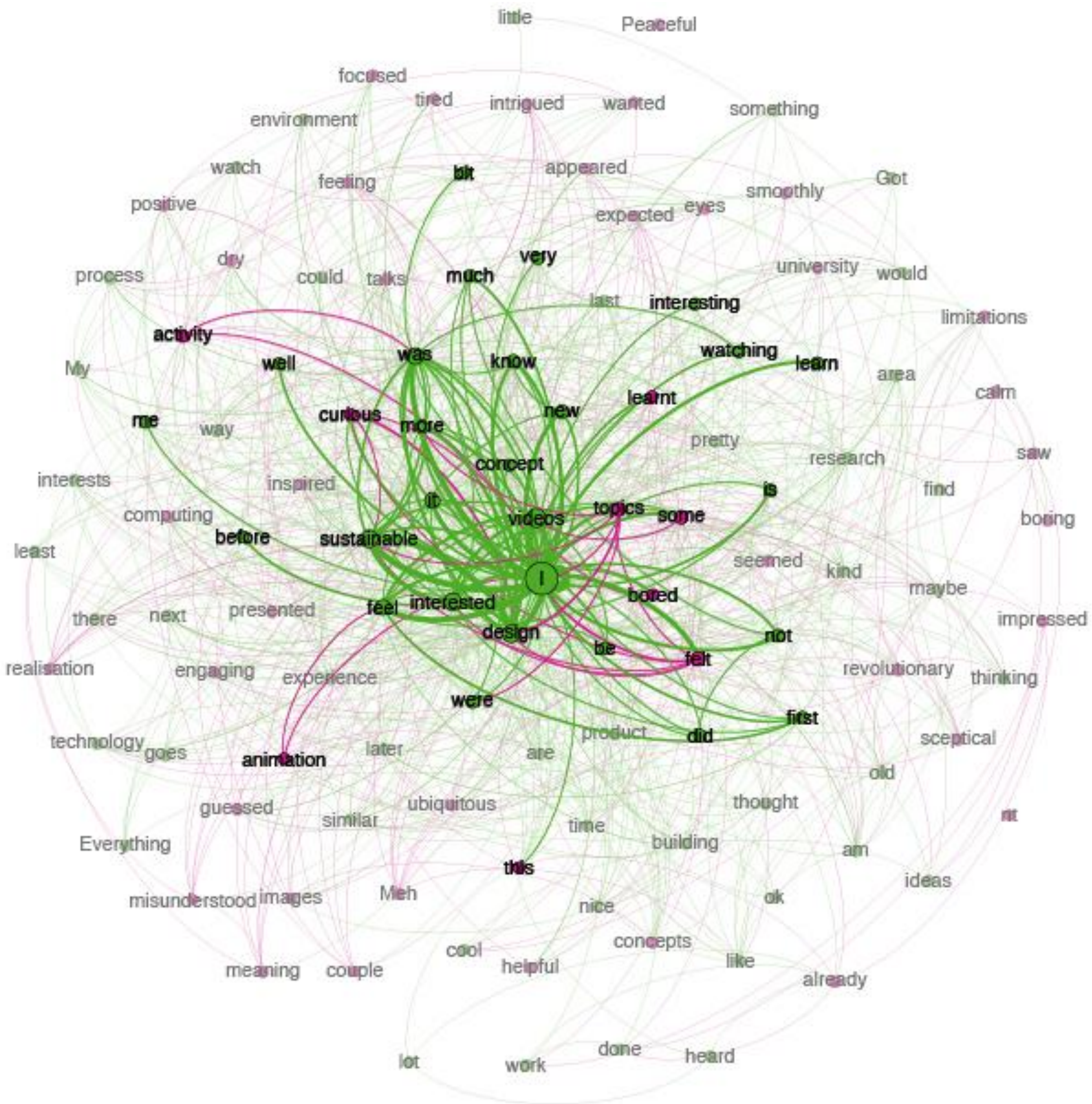
Figure 83. Semantic Network of English Speakers Definition of Sustainable Design After the Intervention (N=173, Node size = 24 to 1, Tie thickness = 14 to 1)



Despite that most videos both in YouTube and in the recommendation system were about architecture, this word was employed in definitions by only two YouTube users. Definitions of recommendation system users were more biospheric, with two participants of the full intervention group conceptualizing it as *not for profit.* Notably, one participant of the half intervention group provided a definition based on public choice theory, conceptualizing sustainable design as a new way to get money.

Regarding feelings, Figure 84 illustrates the semantic graph of 20 answers provided after watching videos. Node size reflects word frequency and ties, which terms were used together. The word *learn* was tied to positive terms and to *university*, while *animation* was tied with both positive and negative words. This confirms the connection between sustainable design and knowledge discussed in semantic networks from Chapter IV.

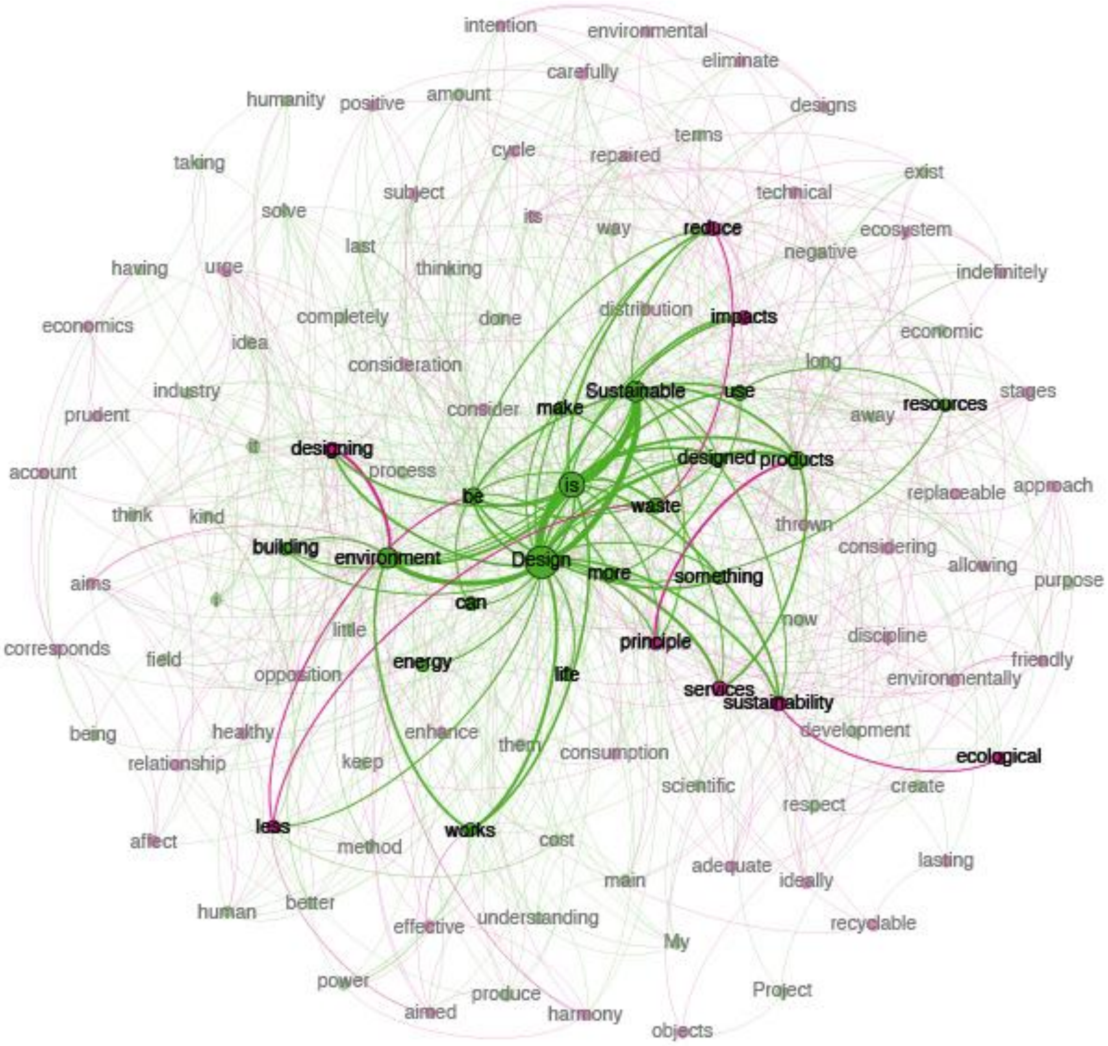
Figure 84. Semantic Network of English Speakers Feelings Towards Sustainable Design After the Intervention (N=118, Node size = 28 to 1, Tie thickness = 11 to 1)



Further, *computing* and *technology* were mentioned in relationship with videos that presented new information to the participants, eliciting mostly positive feelings. Overall, users of the recommendation system employed more positive words to describe their feelings towards sustainable design than YouTube users, some even verbally stating that they wanted to watch more. This is congruent with English speakers' self-report of feelings in a numerical scale and their SentiStrength polarity scores.

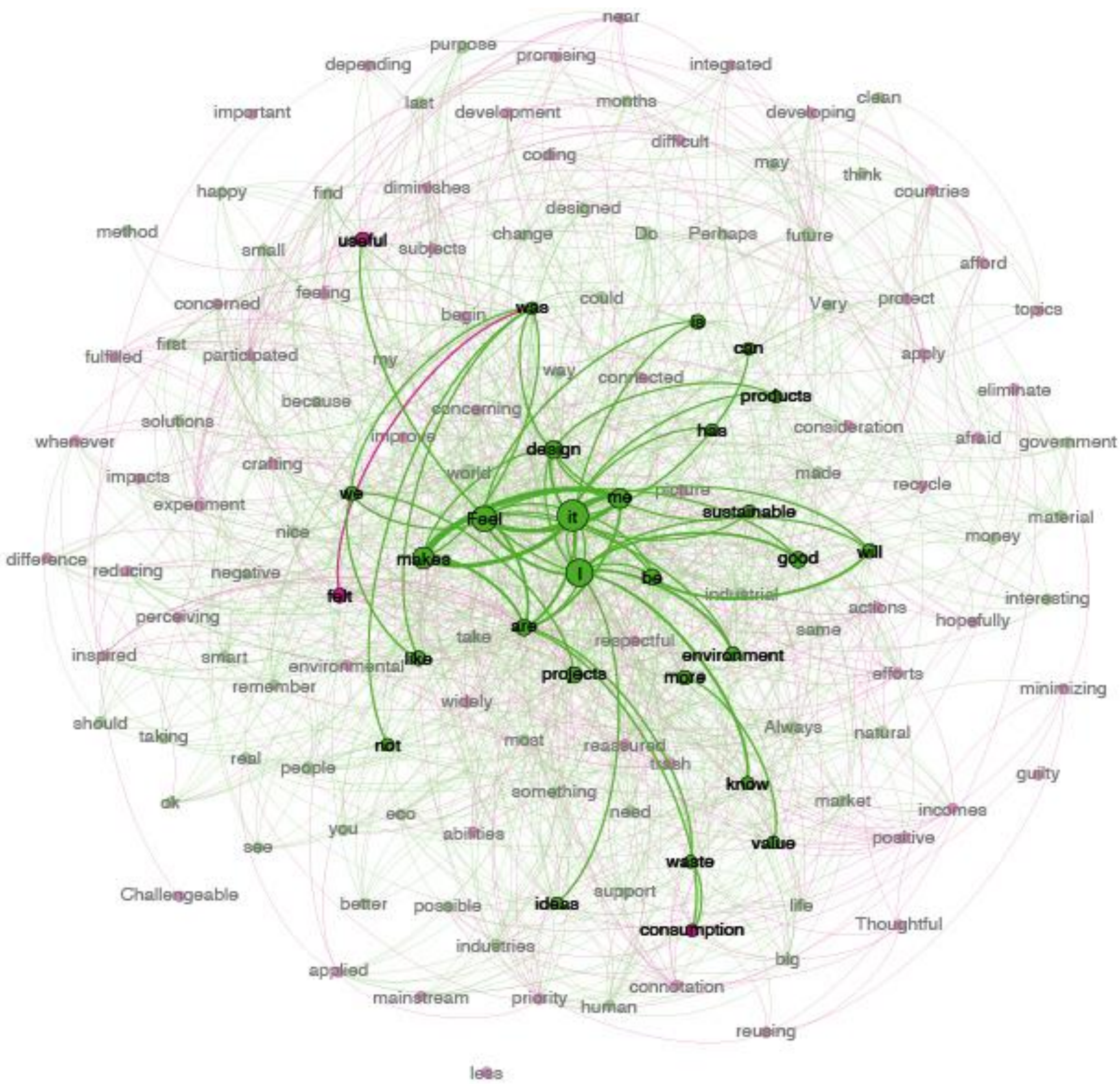
English definitions two months later are reflected in Figure 85, where node size represents word frequency and ties, which words were used together. Although most frequent words are related to the environment, a more encompassing term (*life*) was used. Among terms used once, *humans*, *humanity*, *economic, healthy* and *scientific* are included, pointing to a more integrated, complex and humanized conceptualization of sustainable design. Definitions tended to mention the environment across groups, but recommendation system users tended to provide a more integrated concept including people, and half intervention participants were more focused in efficiency of products and services.

Figure 85. Semantic Network of English Speakers Definition of Sustainable Design 2 Months After the Intervention (N=115, Node size = 19 to 1, Tie thickness = 11 to 1)



Words describing feelings related to sustainable design 2 months later can be consulted in Figure 86, where node size reflects word frequency and tie, which words were used together. Positive and cognitive terms emerged, while among words used once, *difficult* was found. Most answers describing ambivalent feelings were given by half intervention participants, while the other groups gave mostly positive answers. This is congruent with sentiment scores reported in the numerical scale, pointing once more to the importance of a combination between positive feelings and a high interest in sustainable design in order to keep designing actively.

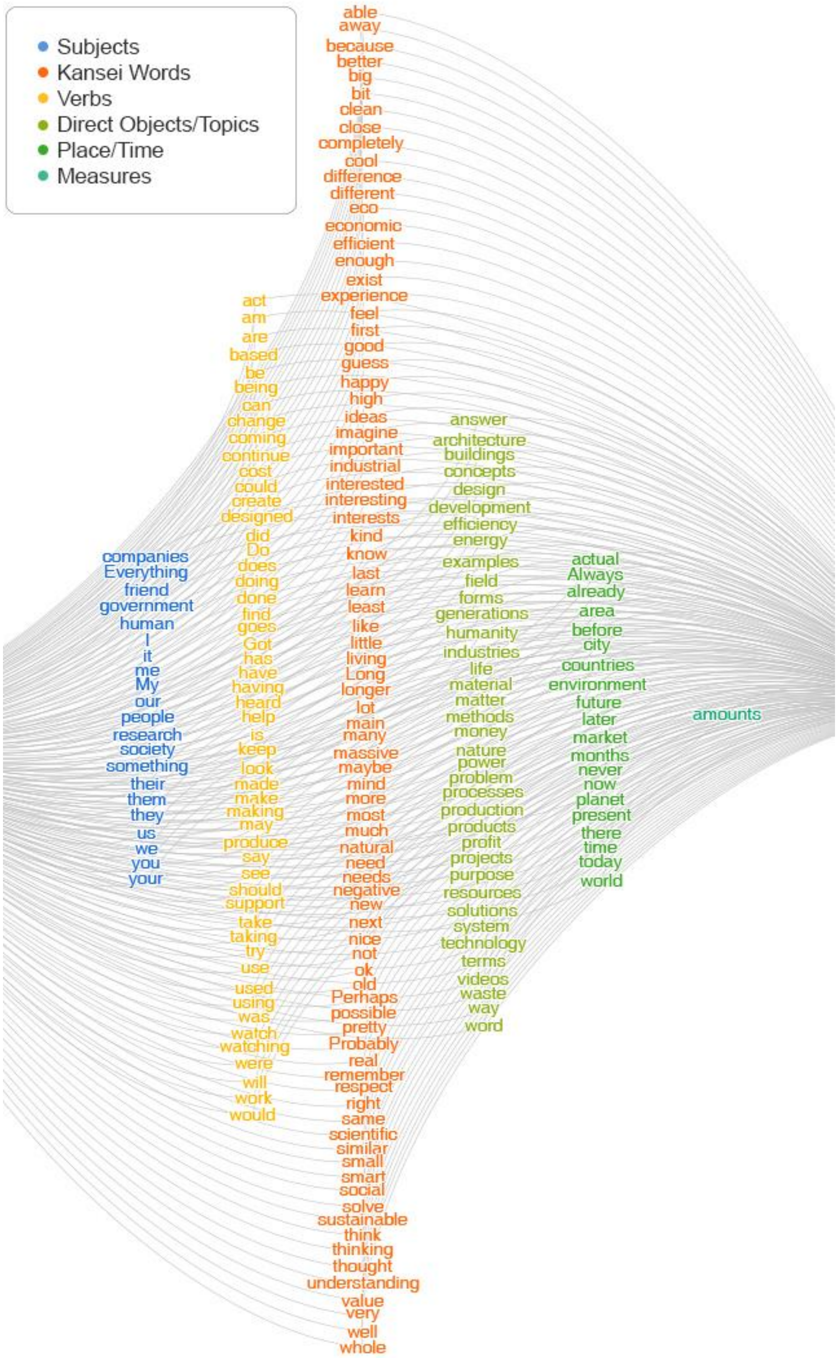
Figure 86. Semantic Network of English Speakers Feelings Towards Sustainable Design After the Intervention (N=143, Node size = 12 to 1, Tie thickness = 6 to 1)



In sum, definitions of sustainable design by English speaking users of the recommendation system tended to focus in the environment and production processes before the intervention, transitioning towards more integral and complex definitions after the intervention. Meanwhile, YouTube users remained focused on the environment and production processes in their definitions. Feelings were mostly linked to the environment and production processes before the intervention, extending towards social and economic factors after using the recommendation system. On the other hand, YouTube users' feelings were still linked to the environment, production processes and themselves.

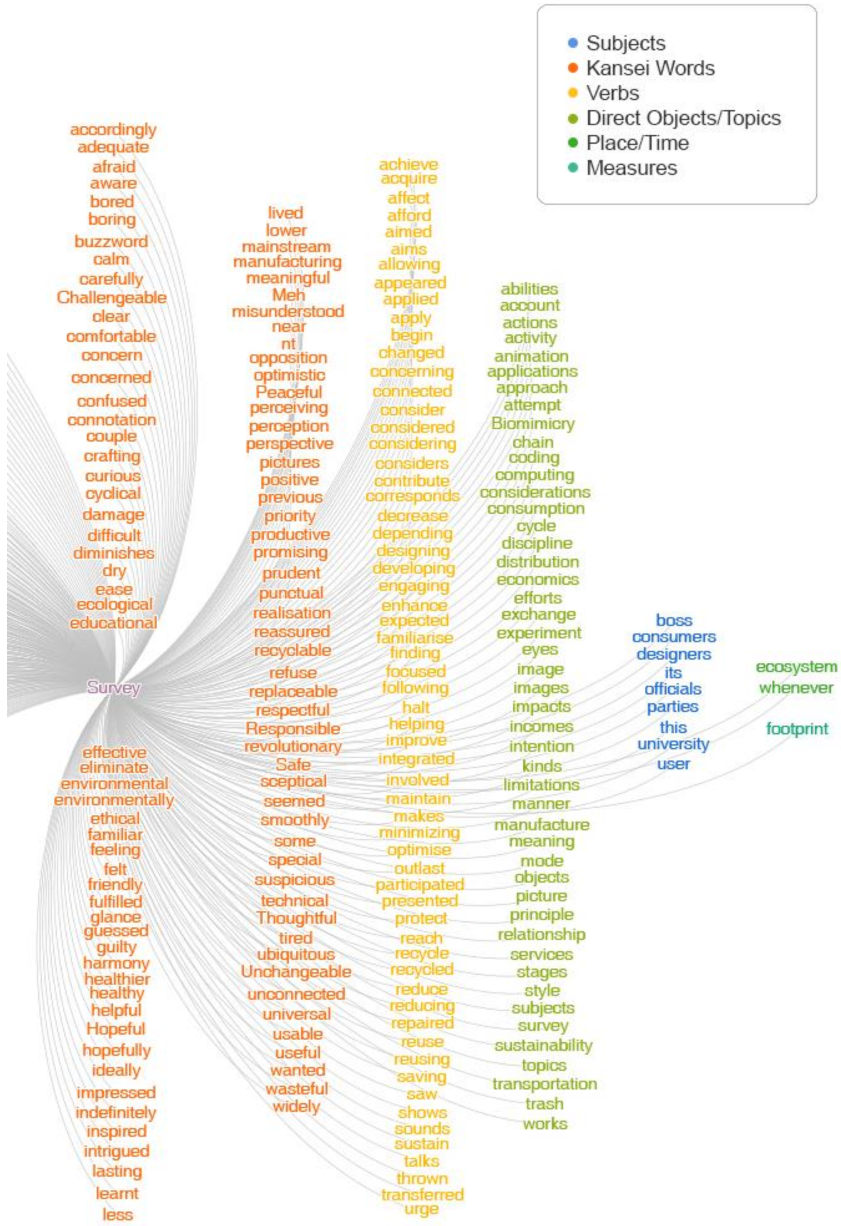
Regarding semantic coincidences, Figure 87 shows which frequent English words were present in the YouTube comments analysed in Chapter IV and also present in the survey's answers. These words are architecture and energy oriented, depict environment, social and economic aspects, complexity and knowledge. Further, they conceptualize sustainable design as a problem-solving oriented discipline. The terms were mostly objective and cognitive oriented words, with few positive terms like *cool*, *happy* and *help*. Overall, the words confirm main findings of Chapter IV, although only 182 of 613 (29.69%) terms were similar. This might be because most videos analysed in previous chapters were from the U.S. and UK, thus attracting comments from YouTube users with the same nationalities.

Figure 87. English Semantic Coincidences



Unique English words contained in the survey's answers are shown in Figure 88. Although most of them are variations on the words included in the lexicon, there are more advanced techniques like biomimicry and the scope of design includes coding and computing.

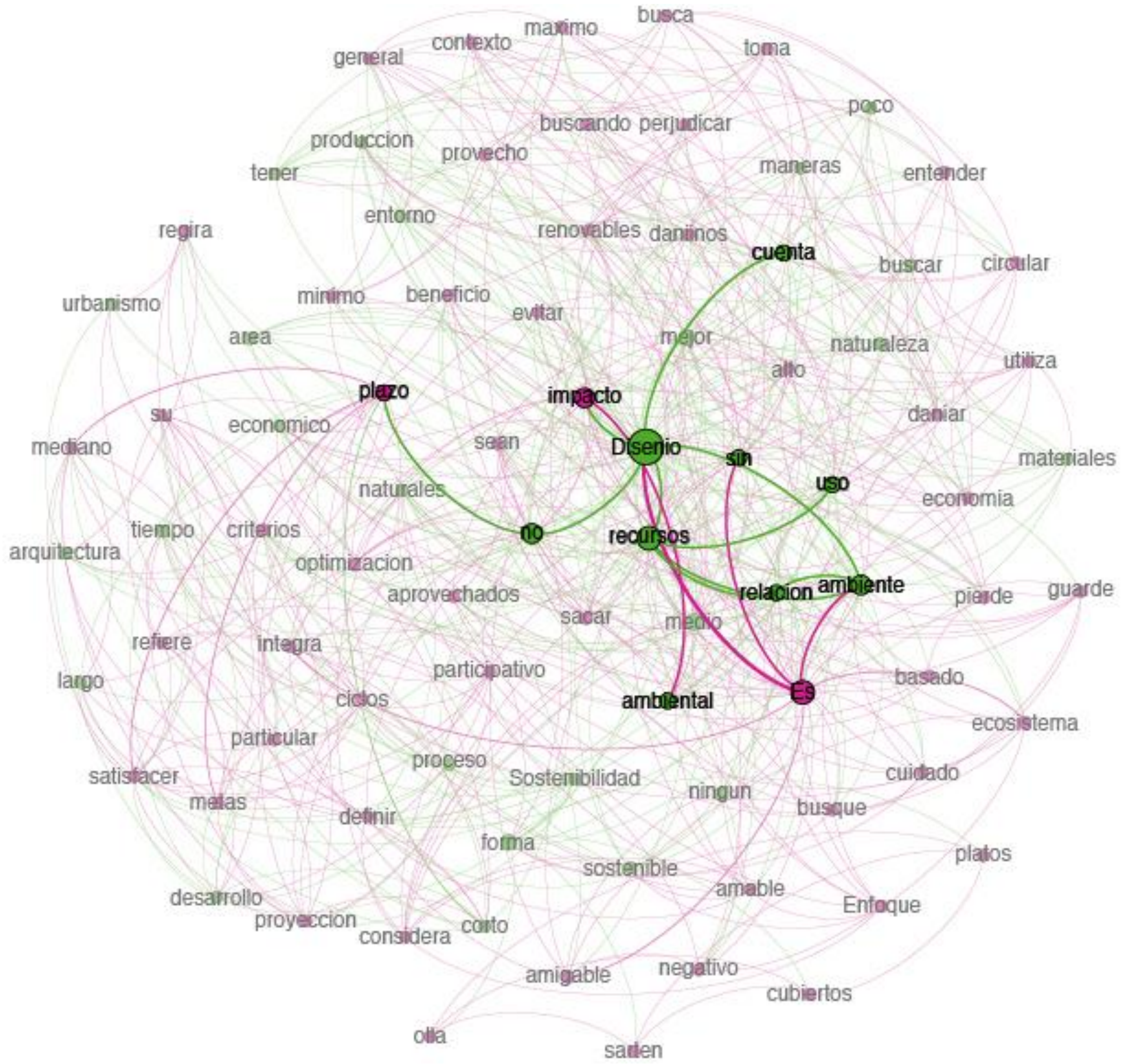
Figure 88. Unique Words Employed by English Speaking Participants in the Surveys



21.5.2 Spanish Semantic Networks

One mode networks with aggregation per corpus and distance 15 by paragraph were calculated with ConText and drawn with Gephi. Figure 89 illustrates definitions of sustainable design given by 9 participants, with node size representing word frequency, ties representing which terms were used together, and green representing which words were present in both the survey answers and the lexicon. In similar terms with English, frequent words included *impacto* (impact) and *ambiente* (environment). However, several terms related to time periods were included, pointing to a more segmented and concrete view of future time for Spanish designers. Other relevant words were *economía* (economics) and *cuidados* (care).

Figure 89. Semantic Network of Spanish Speakers Definition of Sustainable Design Before the Intervention (N=87, Node size = 7 to 1, Tie thickness = 3 to 1)



The 12 participants answers about feelings towards sustainable design are illustrated in Figure 90, with node size reflecting word frequency, and ties, which words were used together. Frequent words included *pensar* (think), *ayuda* (helps), and *no me hace sentir* (does not make me feel), which point to a conception of sustainable design as cognitive related, similar to English results. Among terms used once, method related words were found, but *sociedad* (society) was mentioned, in contrast with English speaking designers, who did not mention humanity related terms in this answer.

Figure 90. Semantic Network of Spanish Speakers Feelings Towards Sustainable Design Before the Intervention (N=63, Node size = 5 to 1, Tie thickness = 4 to 1)

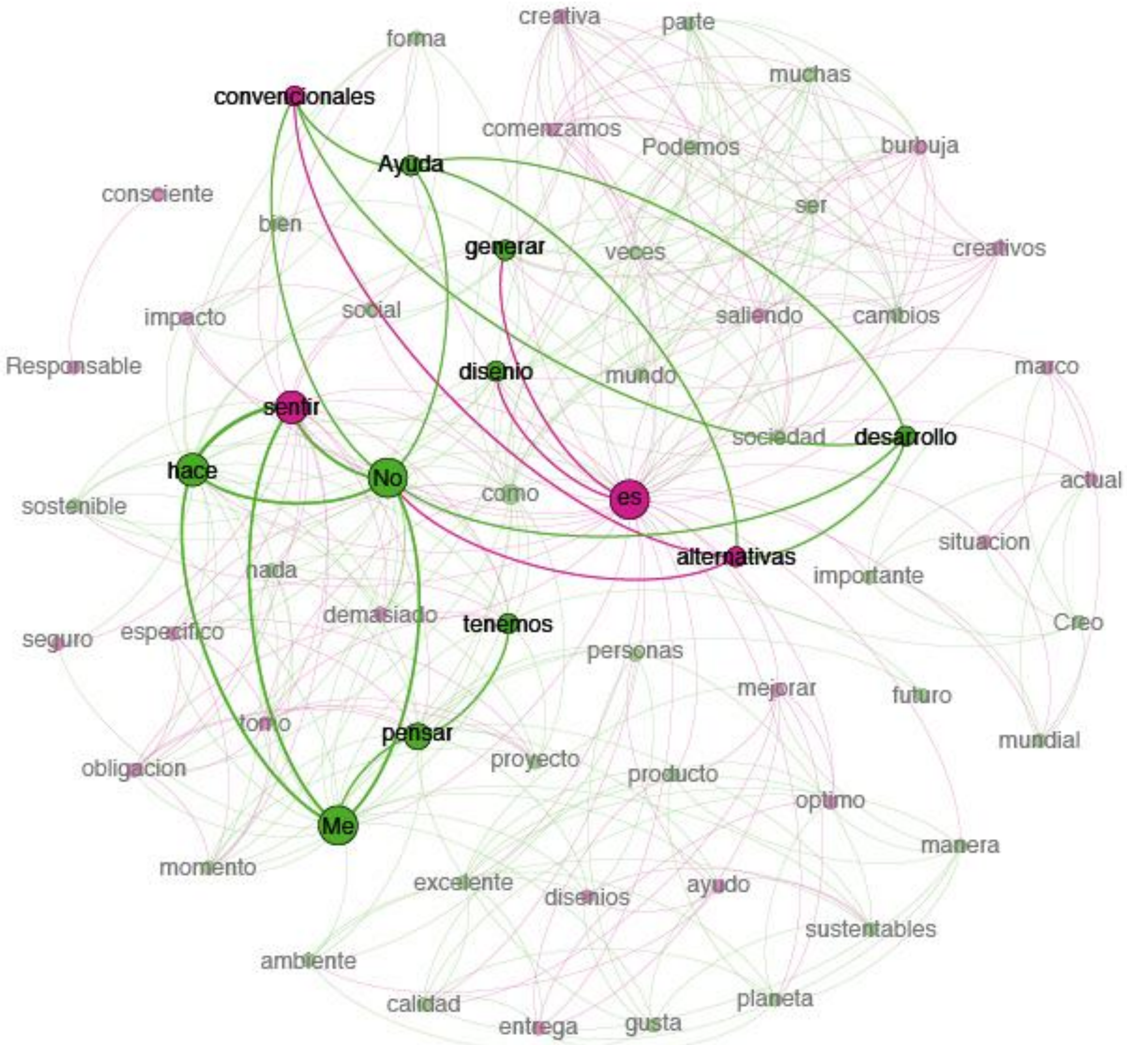
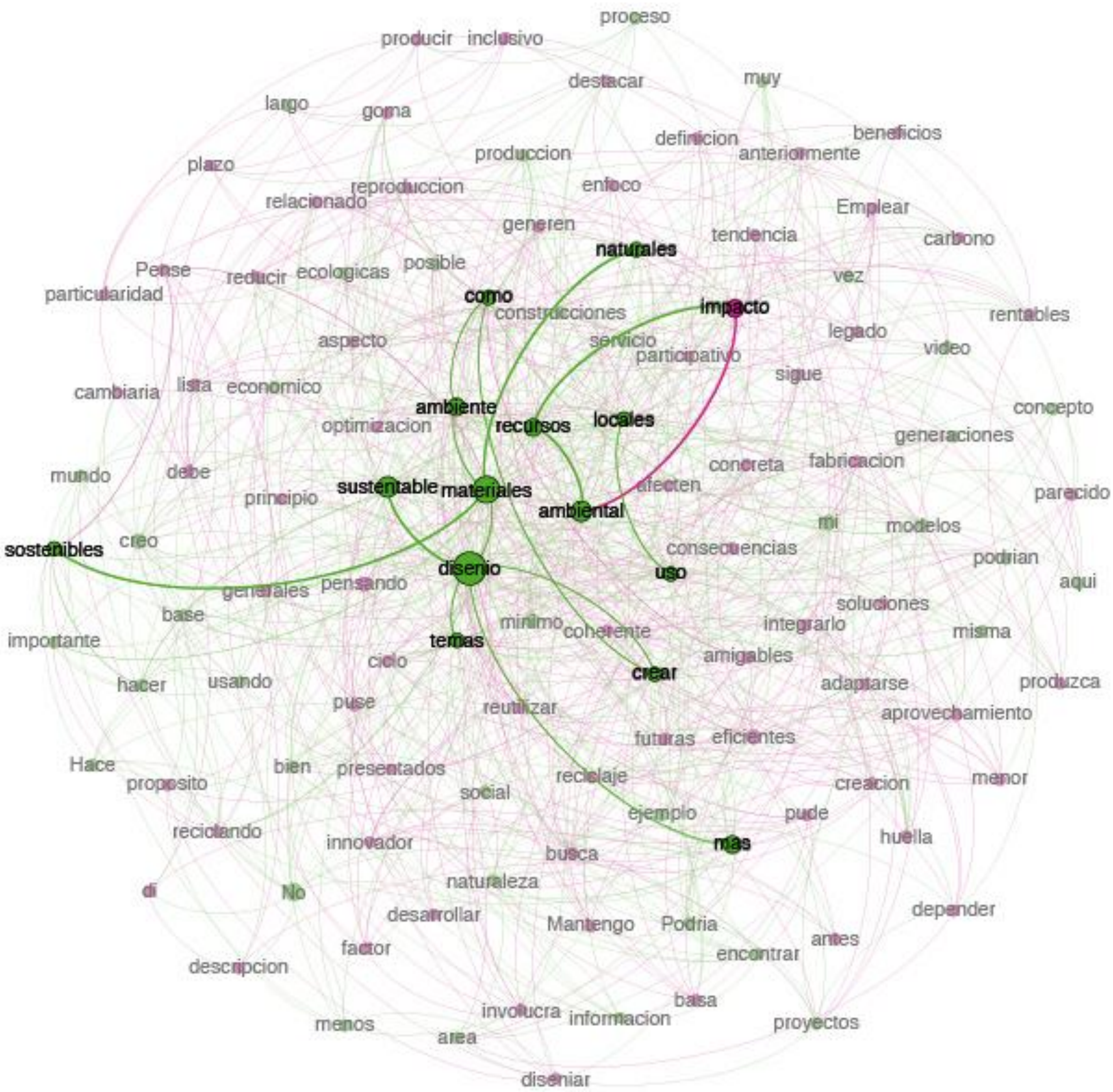


Figure 91 shows the definitions of sustainable design by Spanish speakers after watching videos, with node size equivalent to word frequency and ties showing which terms were used together. Biospheric words increased, but also *locales* (local) was mentioned. Among terms used once, economic related terms and *generaciones* (generations) were found. Hence, a more integral definition emerged among Spanish designers as well, although definitions tended to be biospheric across treatment groups.

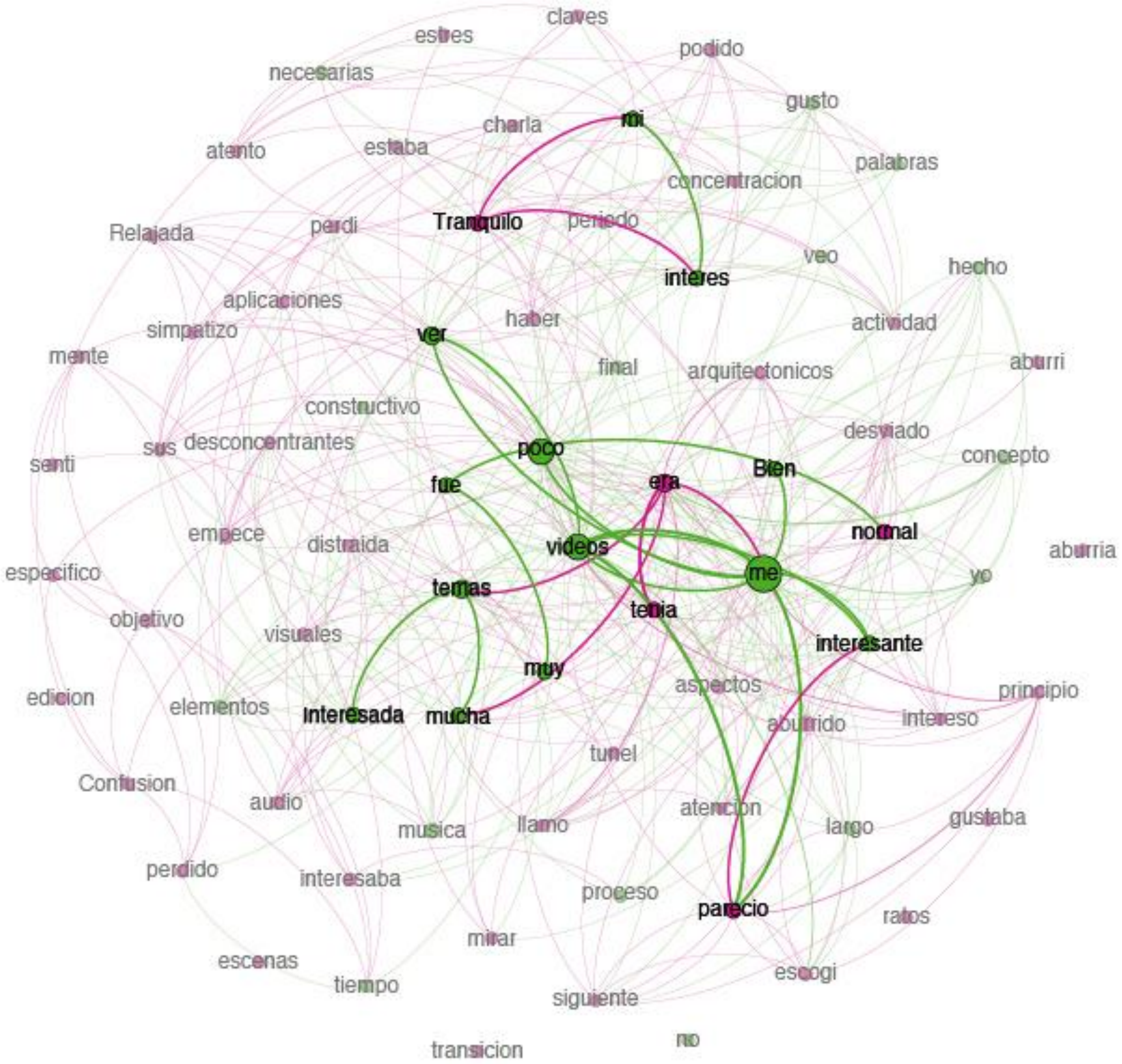
Figure 91. Semantic Network of Spanish Speakers Definition of Sustainable Design After the Intervention (N=119, Node size = 8 to 1, Tie thickness = 3 to 1)



Regarding feelings, Figure 92 illustrates answers provided after watching videos. Node size represents word frequency and ties, which terms were used together. Words related to interest and calm emerged along with positive terms. Among terms mentioned once, *aburrido* (boring), *desconcentrante* (unfocused), *desviado* (deviated), *estrés* (stress), *perdido* (lost) and *túnel* (tunnel) were found. Cognitive processes apparently were connected to the most frequent words, which confirms again a link between sustainable design and knowledge. However, most comments were ambivalent across treatment groups, which coincides with

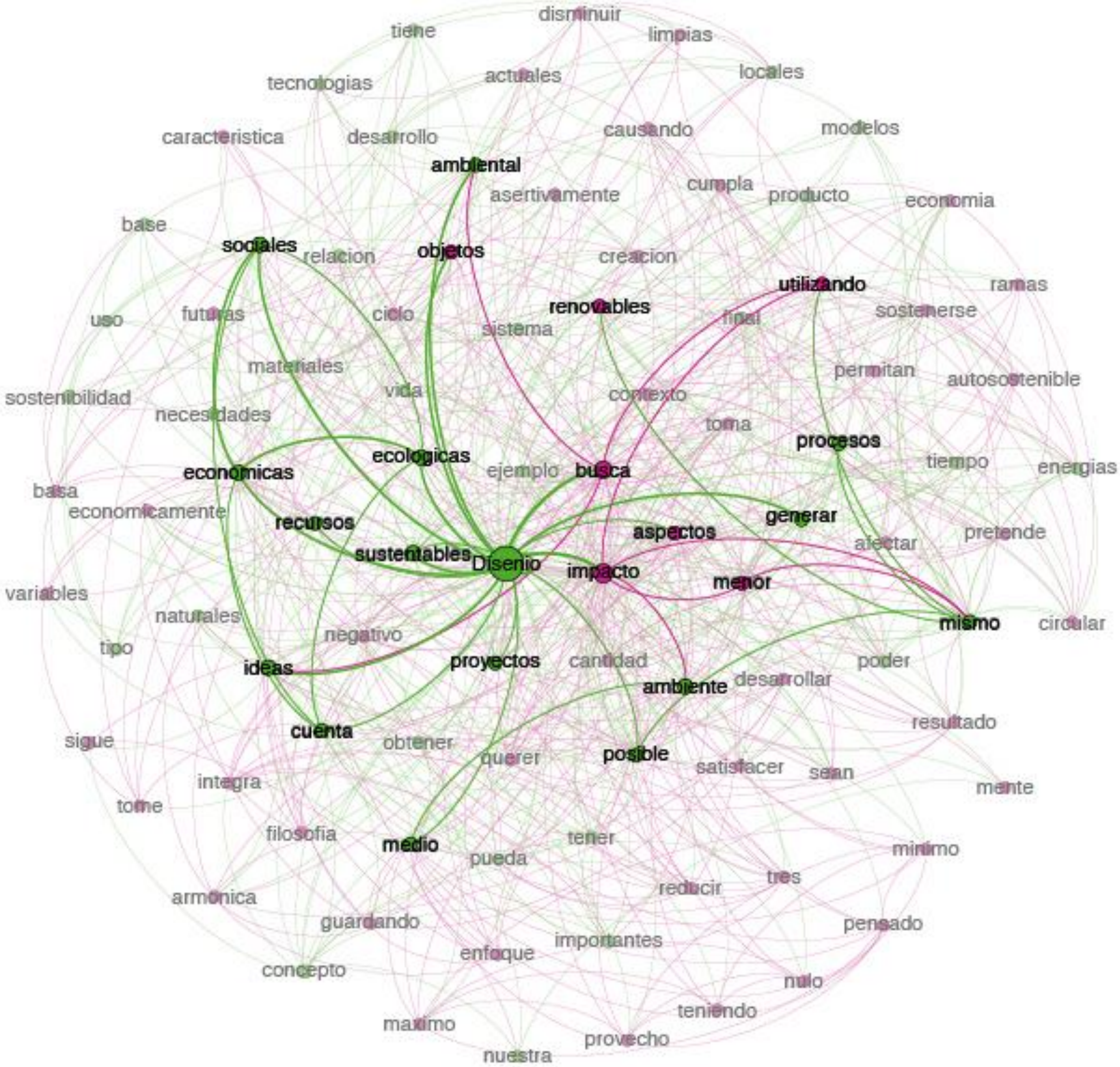
Spanish speakers' self-report of feelings in a numerical scale and their SentiStrength polarity score.

Figure 92. Semantic Network of Spanish Speakers Feelings Towards Sustainable Design After the Intervention (N=79, Node size = 10 to 1, Tie thickness = 3 to 1)



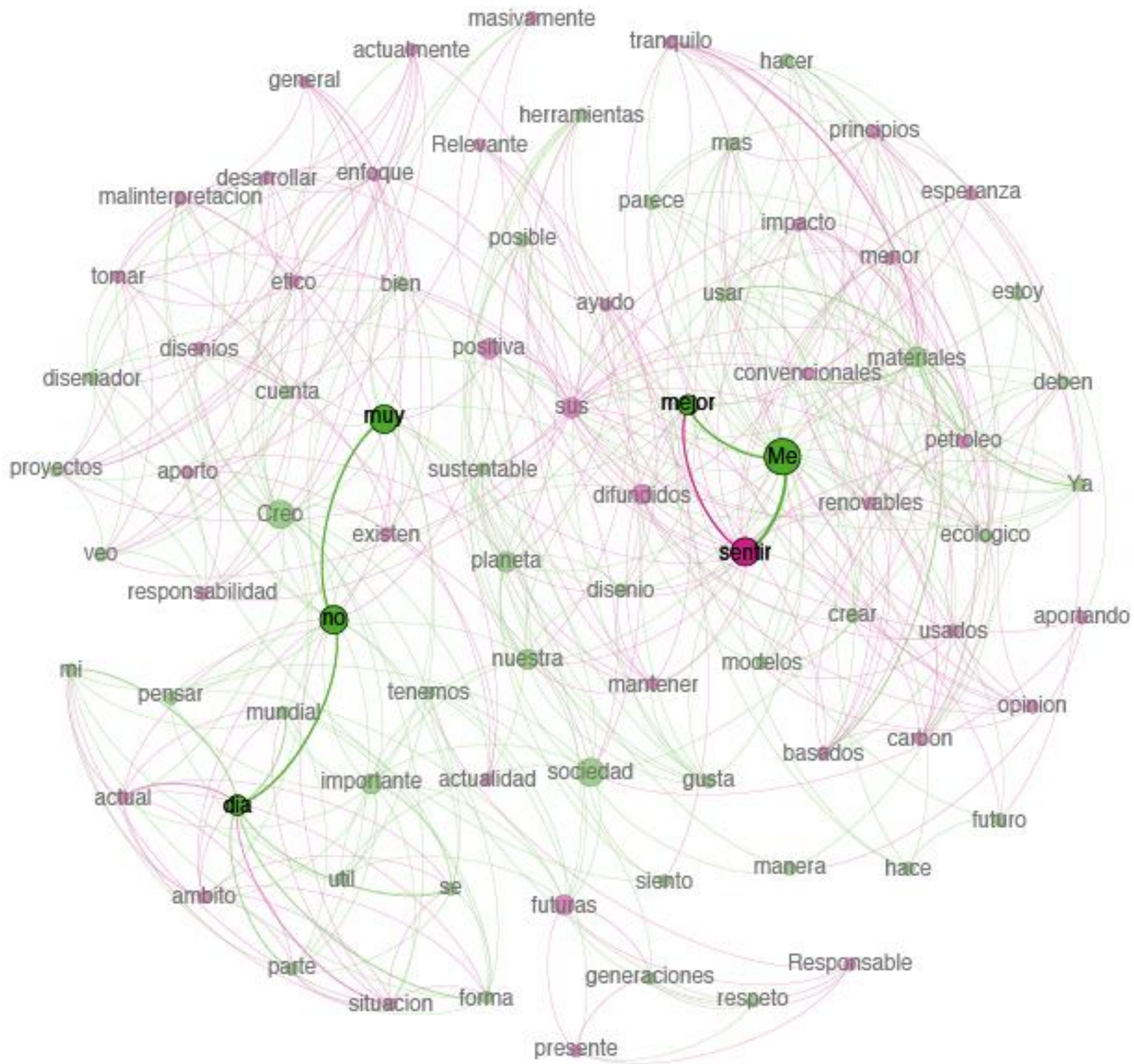
Spanish definitions of sustainable design two months later are shown in Figure 93, where node size reflects word frequency and ties, which words were used together. Definitions were once more integrated, with economic, social and environmental aspects frequently mentioned across all intervention groups. Among words used once, *locales* (local), *filosofía* (philosophy) *tecnologías* (technologies) were found, pointing to a conceptualization of sustainable design closer to that from WEIRD countries.

Figure 93. Semantic Network of Spanish Speakers Definition of Sustainable Design 2 Months After the Intervention (N=96, Node size = 14 to 1, Tie thickness = 4 to 1)



Descriptions of feelings related to sustainable design 2 months later are illustrated in Figure 94, where node size represents word frequency and tie, which words were used together. Frequent terms were *sentir mejor* (feel better) and *día* (day), alluding to the present times. Social and environment related words were used once, but not economic related terms, in contrast with English answers. YouTube users mentioned the future, while system recommendation users mentioned present and future time frames.

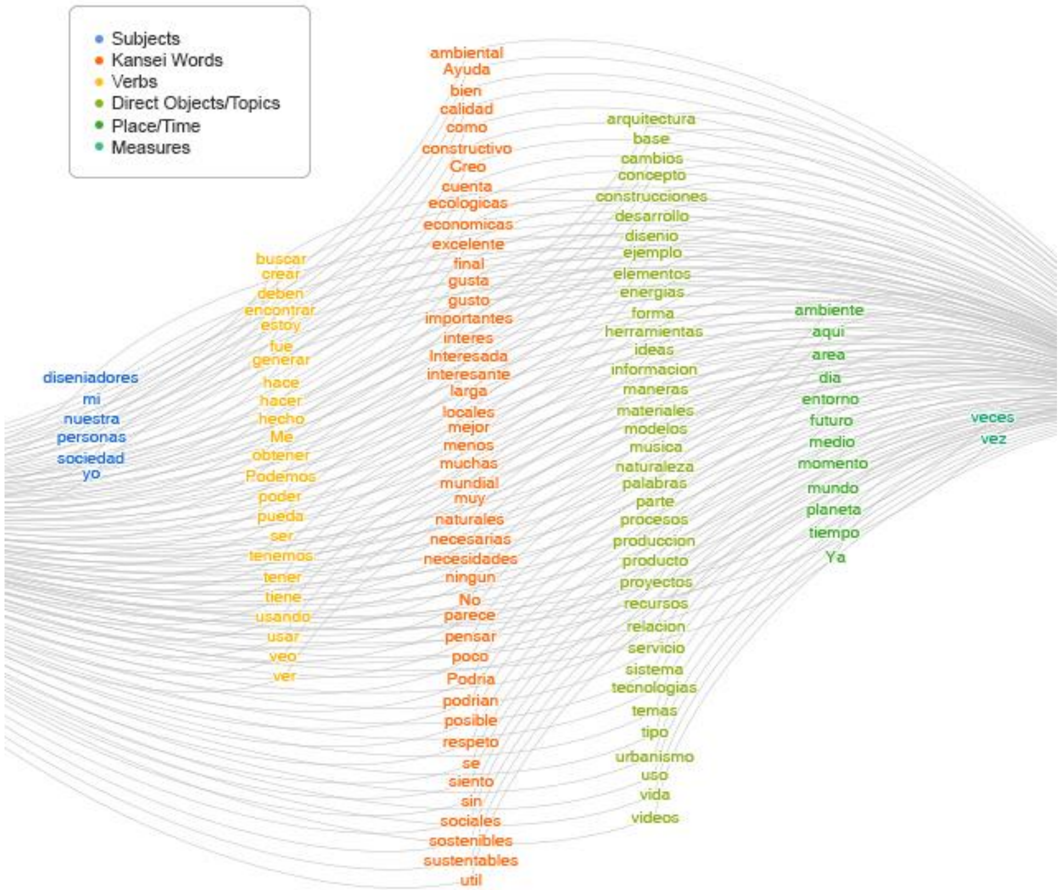
Figure 94. Semantic Network of Spanish Speakers Feelings Towards Sustainable Design After the Intervention (N=143, Node size = 12 to 1, Tie thickness = 6 to 1)



In sum, there were no particular differences in definitions by Spanish speaking participants before the intervention. There was a transition towards integral definitions with emphasis in environmental factors across all groups after the intervention, and more balanced definitions with WEIRD characteristics 2 months later. Feelings were mostly linked to production processes, society, environment and the self before the intervention, changing towards cognitive and production processes after the intervention. Two months later, feelings were extended towards social and environmental factors, while the time framework of YouTube users was more similar to English users, and recommendation system users time framework was more detailed. However, full intervention group participants focused more on their own feelings.

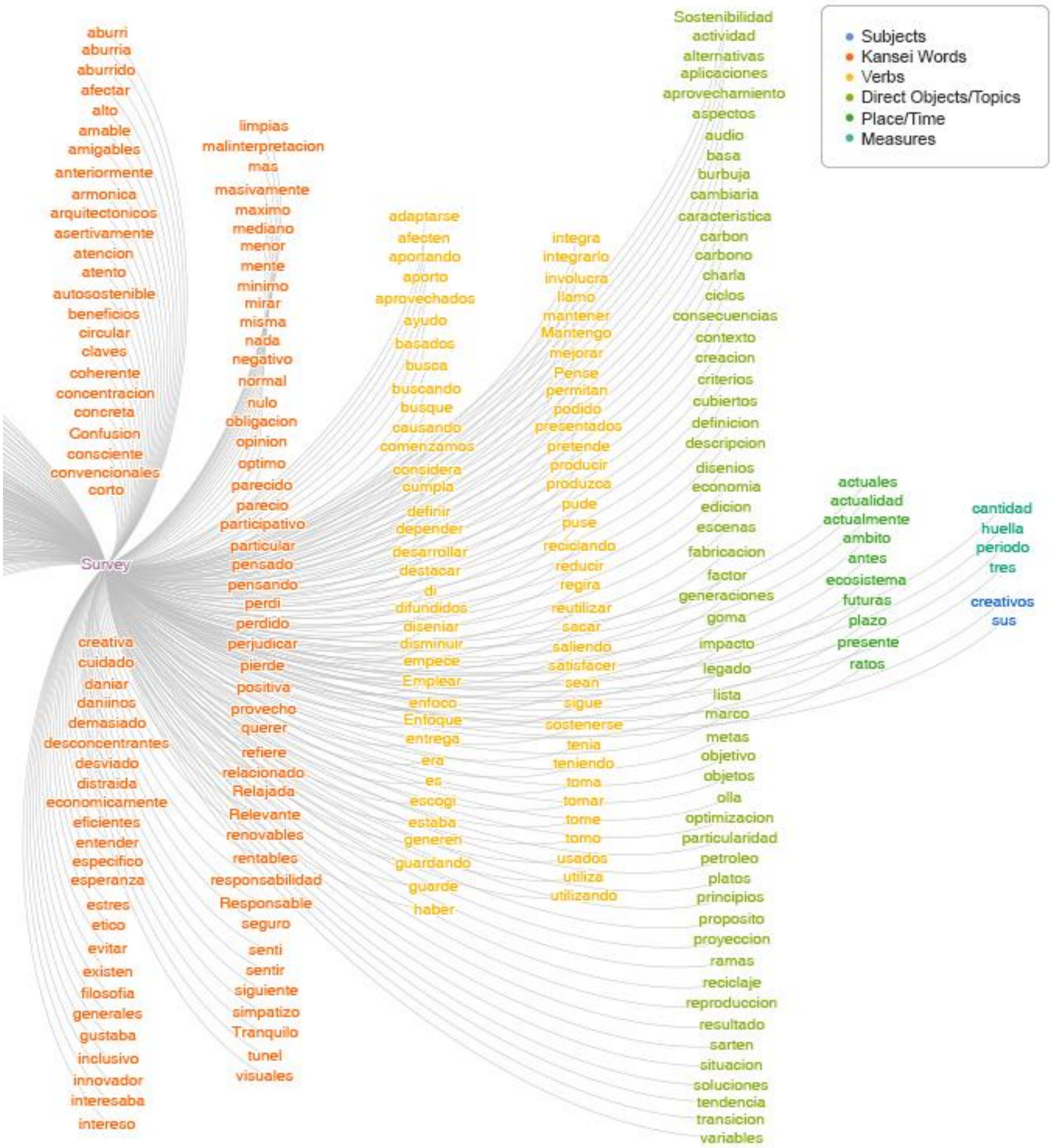
Regarding semantic coincidences, Figure 95 shows Spanish words frequently present in the YouTube comments analysed in Chapter IV and the survey. These words are, once more, architecture and energy oriented, describing environment, social and economic aspects, complexity and knowledge. However, the terms are more oriented towards materials, methods and tools. Words like *excelente* (excellent), *interesante* (interesting) and *útil* (useful) were included. Such coincidences reaffirm the project-oriented nature of sustainable design in Spanish, confirming findings of previous chapters. However, only 110 of 614 (17.95%) words were similar, probably due to most videos being uploaded from Spain, although Spanish is richer in terms of vocabulary than English.

Figure 95. Spanish Semantic Coincidences



Unique Spanish words contained in survey's answers were included in Figure 96. Although most were variations on words and topics found in the lexicon, references to visual and audio resources, and several negative words were mentioned. This is pointing to the quality of Spanish videos, which several participants mentioned was low during the interviews.

Figure 96. Unique Words Employed by Spanish Speaking Participants in the Surveys



21.6 Statistical Analysis

Because a Kruskal Wallis test did not show significant differences between the 3 treatment groups, a Mann-Whitney test was conducted between the no intervention group and the aggregated data of the 2 intervention groups. The complete test can be consulted in Annex 38. Results indicate that number of projects 2 months later was higher for the intervention group ($Mdn1=13$, $Mdn2=18.09$, $U=75$, $p<0.05$).

There were more differences depending on the participants language. Table 52 shows a summary of Mann-Whitney test (details can be consulted in Annex 39). After the intervention, negative sentiment, emotionality, self-reported sentiment, interest; and polarity 2 months later were significantly ($p<0.05$) different, suggesting cultural differences in the experienced emotions.

Table 52. Summary of Mann-Whitney U Test According to Language

Variable		N	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
SentiStrength Negative Sentiment After Intervention	English	20	18.88		
	Spanish	12	12.54		
	Total	32		72.500	.031
Emotionality After Intervention	English	20	12.93		
	Spanish	12	22.46		
	Total	32		48.500	.004
Sentiment Likert After Intervention	English	20	19.43		
	Spanish	12	11.63		
	Total	32		61.500	.019
Interest After Intervention	English	20	14.03		
	Spanish	12	20.63		
	Total	32		70.500	.047
SentiStrength Polarity 2 Months Later	English	20	14.15		
	Spanish	12	20.42		
	Total	32		73.000	.039

A regression analysis of number of projects after 2 months showed that the Mixed area (which includes engineering), interest after 2 months and interest post intervention were significant predictors.

Table 53. Regression of Number of Projects After 2 Months (N=32, $p<0.05$)

Variable	Sum of Squares	df	Mean Square	F	Adj. R Square
Interest After Intervention	6.141	1	6.141	9.031	.243
Interest 2 Months Later	12.854	2	6.427	15.386	.535
Expertise_Mixed	15.486	3	5.162	16.281	.647

Regression analysis on interest after 2 months was also conducted. Table 54 shows that the top predictor was interest after the intervention, followed by whether the participants belonged to the no intervention group and their reported sentiment two months later. Therefore, results suggest that YouTube did not have a permanent effect on interest and that a moderately positive sentiment might be related to continuous interest in sustainable design.

Table 54. Regression of Interest After 2 Months (N=32, $p<0.001$)

Variable	Sum of Squares	df	Mean Square	F	Adj. R Square
Sentiment Likert 2 Months Later	36.011	1	36.011	23.555	.421
Condition_No Intervention	53.405	2	26.703	27.200	.628
Interest After Intervention	60.514	3	20.171	26.441	.711

Number of projects of 32 participants after 2 months was slightly correlated with expertise in industrial design *($r=0.354$, $p<0.05$)*. Interest after 2 months was slightly correlated with initial interest *($r=0.405$, $p<0.05$)*, sentiment in the Likert scale *($r=0.467$, $p<0.005$)*, correlated with interest after the intervention *($r=0.615$, $p<0.005$)* and sentiment in the Likert scale after 2 months *($r=0.755$, $p<0.005$)*.

Further, interest after the intervention was slightly correlated with language *($r=-0.357$, $p<0.05$)*, initial SentiStrength negative score *($r=0.484$, $p\leq 0.005$)*, sentiment in the Likert scale *($r=0.419$, $p<0.05$)*; SentiStrength negative score *($r=0.434$, $p<0.05$)* and polarity score *($r=0.408$, $p<0.05$)* 2 months later; and correlated with initial interest *(r=0.557, p<0.005)*. Gender and age did not correlate with variables relevant to the present study.

In sum, there appears to be a relationship between high interest, moderate positive sentiment and continuous practice of sustainable design. There is also some indication that negative feelings were related to interest after the educational intervention; and that the role of both feelings and interest was more prominent than demographic variables such as age and gender.

To investigate interest post intervention further, Mann-Whitney test was conducted in the eye-tracking data according to whether the participants used YouTube or the recommendation system to watch videos. Table 55 shows that total watching time, design objects watching time and total fixation time were significantly longer *(p<0.05)* for participants who used the video recommendation system. This suggests that design objects in videos exposed during the intervention might have been more interesting for members of the intervention group, which is supported by semantic analyses and conversations held with the participants after watching the videos.

Otherwise, fixation time and average fixation time on money were significantly shorter *(p<0.05)* for participants who used the video recommendation system than for YouTube users. This might be related to the acquired/reinforced notion that sustainable design is not for profit, as supported by semantic analyses and conversations post-intervention.

Table 55. Summary of Mann-Whitney U Test in Eye Tracking Data
According to Treatment Groups

Variable	Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Asymp. Sig. (2-tailed)
Video Watching Time	YouTube Users	8	6.50	52.00		
	Rec. Sys. Users	10	11.90	119.00		
	Total	18			16.000	.033
Design Objects Watching Time	YouTube Users	8	6.50	52.00		
	Rec. Sys. Users	10	11.90	119.00		
	Total	18			16.000	.033
Video Watching	YouTube Users	8	5.88	47.00		
	Rec. Sys. Users	10	12.40	124.00		

Fixation Time	Total	18			11.000	.010
Money Fixation Time	YouTube Users	8	11.75	94.00		
	Rec. Sys. Users	10	7.70	77.00		
	Total	18			22.000	.043
Average of Money Fixation Time	YouTube Users	8	11.75	94.00		
	Rec. Sys. Users	10	7.70	77.00		
	Total	18			22.000	.043

There were no significant differences in a Mann-Whitney U Test according to language (Annex 40). However, watching time, average of watching time and fixation time in Living Beings was significantly higher ($p<0.05$) among Asian participants (Table 56). Furthermore, their positive sentiment and emotionality scores post intervention were significantly lower ($p<0.05$) than those of other nationalities. This result can be interpreted as being calm and neutral in relationship to watching more animals, plants and raw materials.

Table 56. Summary of Mann-Whitney U Test in Eye Tracking Data According to Asian Nationality

Variable	Nationality	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Asymp. Sig. (2-tailed)
No Knowledge about Sustainable Design	Other	10	7.20	72.00		
	Asian	8	12.38	99.00		
	Total	18			.018	.043[b]
SentiStrength Positive Sentiment After Intervention	Other	10	12.45	124.50		
	Asian	8	5.81	46.50		
	Total	18			.005	.006[b]
Emotionality After Intervention	Other	10	12.65	126.50		
	Asian	8	5.56	44.50		
	Total	18			.004	.003[b]
Living Beings Watching Time	Other	10	6.70	67.00		
	Asian	8	13.00	104.00		
	Total	18			.013	.012[b]

Average of Living Beings Watching Time	Other	10	6.90	69.00		
	Asian	8	12.75	102.00		
	Total	18			.021	.021[b]
Living Beings Fixation Time	Other	10	6.70	67.00		
	Asian	8	13.00	104.00		
	Total	18			.013	.012[b]
b Not corrected for ties.						

22 DISCUSSION

22.1. Cognitive And Emotional Dynamics Of English Speaking Designers Related To Sustainable Design

The most noted characteristic of English speakers when conceptualizing sustainable design was that most did not provide a definition before the intervention. A few mentioned later that they heard the term but were not sure of its meaning, so they chose to leave the answer blank. Because the half intervention participants were more focused in efficiency of products and services in their answers, the need for a full intervention emerges to reaffirm the social and biospheric dimensions of sustainability among English speakers.

According to observations by the researcher and the eye-tracking data, English speaking participants got bored after approximately 9 minutes of watching videos. They responded well to negative emotions embedded in new information, as several mentioned they liked animations that communicated sustainable design according to its 3 main components (ecology, people and economy), and/or learning about the life cycle of products in a playful way. Moreover, their negative emotions apparently were longer lasting than Spanish ones. Such emotions, if left unmanaged as in the case of half intervention participants, apparently led to less activity related to sustainable design two months later, hence the importance (again) of the full intervention.

In sum, English speakers apparently benefited more from the intervention because: a) most of those who did not know or experienced sustainable design were among this group; b) they were exposed to video content better suited to beginners;

c) they were exposed to video content better suited to their design fields and from diverse sources; and d) the interface of the recommendation system helped them focus on the video. All these factors apparently contributed to their generally positive reaction and to an increase on their interest towards sustainable design.

22.2. Cognitive And Emotional Dynamics Of Asian Designers Related To Sustainable Design

Based on semantic graphs, the conceptualization of time was closer to WEIRD countries although most English-speaking participants were Asian. This result coincides with Leong & Lee (2018), who also found that collectivism and respect towards nature are fading among Chinese and Indian millennials.

According to the Mann-Whitney U test, Asians were more fixated in living beings than participants from other nationalities, which generated more neutral feelings. Their average number of projects two months later was higher than that of participants from other nationalities, although non-significant ($Mdn1=8.9$, $Mdn2=10.25$, $U=.41$, $p>0.05$). Complementing this finding with semantic analysis and conversations post intervention, the inclusion of living beings in videos apparently helped them understanding better their relationship with the design process. Therefore, living beings were beneficial for Asian participants in terms of cognition of sustainable design.

22.3. Cognitive And Emotional Dynamics Of Spanish Speaking Designers Related To Sustainable Design

The definition of sustainable design was more prosocial from the beginning among Spanish speakers, as can be appreciated in the semantic networks. Apparently, the recommendation system contributed to highlight the local dimension of sustainable design, according to the semantic networks. However, the definition became closer to WEIRD countries theory related words 2 months later, probably due to the location of participants in a research-based university from a developed country. YouTube apparently did not have much of an effect in the definitions because more participants had previous knowledge on the topic compared to English speaking participants.

The conceptualization of time was also different because more Spanish speakers knew what sustainable design is beforehand. Therefore, they understood that its practice involves the organization of time at different levels, which helps them to keep designing, as their goals are more concrete and therefore, more realistic than if placed inside a long-term concept of future.

Judging by the relationships between emotions and interests, Spanish speakers required more negative emotions combined with their previous knowledge to foster an increase on their interest towards sustainable design. According to observations by the researcher and eye-tracking data, their attention span tended to be shorter than that of English speakers, feeling bored approximately after 5 minutes of watching videos. However, their watching time roughly matched that of English speakers. Therefore, negative emotions might have contributed to keep their focus on the videos.

Further, some designers who watched videos on techniques for sustainable construction reported feeling bored, but nevertheless kept watching the entire videos. Hence, what could be interpreted as negative feelings might be just neutral feelings elicited by real life role models practicing sustainable design. Apparently, there were no lasting detrimental effects of such drastic emotional changes, as their feelings were positive, their interest was slightly higher and most were doing sustainable design projects 2 months later.

According to semantic networks, the full intervention group was more focused on their feelings. This might be because many of the Spanish speaking designers mentioned they were doing a lot of projects, and that they wanted to do more. Hence, the researcher reminded them that self-care is important and that they can reach out to other people who share their interests to be able to do more sustainable design without burning out. According to semantic analysis, they reported that they felt better 2 months after the intervention. This could also explain why number of projects among Spanish speakers diminished.

A relevant difference between languages was the confirmation of a perception of virtual colonialism among Spanish speakers. Not only English content was shown often in YouTube when they were searching or watching videos in Spanish. Despite that English-speaking designers also mentioned low quality of videos as a negative aspect, they did not request to watch videos in different languages.

Further, Spanish speaking participants mentioned that they preferred videos in English because they were of higher quality than Spanish videos, and that the lack of a big number of options (particularly in the video recommendation system) was annoying. This partly explains their moderate positive feelings after the first part of the intervention. However, this might also point to a different socio-economic audience, as Spanish speaking participants were proficient in English and living in a developed country.

22.4. Coincidences Between Participants

Regarding structural elements in the recommendation system, almost nobody noticed the search bar and hence, they did not use it. Some participants suggested to make a brief tutorial about the system's usage before starting.

Based on the definitions of sustainable design provided by participants before the intervention, they conceptualized this type of design mostly as an environmental issue. Such definitions tended to become more complex, incorporating the three main aspects of sustainable design after using the recommendation system. They were also highly cognitive related, confirming findings in Chapter IV.

Meanwhile the definition of sustainability involves ecological, social and economic aspects, the tendency of businesses and governments is to focus on economy and thus transmit this priority to their constituents. Although economic related benefits were not particularly salient in the videos nor in definitions of sustainable design, visual communication should incorporate them more often because there is a need to make designers: a) realize the economic benefits of sustainable design to dispel myths around it; b) foster complex thinking in the profession; and c) diffuse sustainable design among actors who are resisting it.

Given that biospheric values fail to elicit a quick response from designers that are just beginning to grasp sustainability, this would be an approach to mitigate resistance towards the sustainable design discourse. Long term solutions to its adoption and practice will be included in the general discussion section of the present study.

The strong human component in the communication of sustainable design was confirmed once more. Personalization of videos through the recommendation system fostered a more integrated definition of sustainable design because industrial and graphic designers could find more design objects and designers related to their careers, as reflected in the semantic networks.

Results of a regression analysis on number of projects and relationships with negative sentiment scores in the first 28 participants (Vargas Meza et al., 2018) coincide, although the effect of positive sentiment and definition length after 2 months in number of projects was not confirmed. Therefore, results on predictors of interest related to sustainable design should be taken with caution, as the small number of participants could be representing more specific design communities than those analysed through YouTube videos.

Nevertheless, there is some indication that design fields might be more relevant than level of interest and/or sentiments in terms of sustainable design practice. There was some relationship between number of design projects and industrial design. Several participants from the 3 treatment groups mentioned the lack of variety of content outside architecture. On the other hand, some participants who reported to be involved with sustainable design 2 months later mentioned that now they could understand the application on their areas (concretely industrial and graphic design), and even mentioned how to expand that application further.

Meanwhile, being part of the mixed area (engineering in this case) was a predictor of not being involved with sustainable design. In conversations with participants from this area, they mentioned that sustainability was not a requirement emphasized by their professors, supervisors or colleges. Therefore, the lack of congruency between their background and the videos they watched might have been highly relevant for their adoption of sustainable design related behaviours, and in this case, structural barriers reinforced by social engineered denial might be at play. However, this effect should be confirmed in future research, including other types of designers from the mixed area.

22.5. The Interaction With Video Networking Sites In An Educational Context

Social Networking Sites have been under public and governmental scrutiny in recent years. On the other hand, Kampf (2018) visualized YouTube as a multidimensional space focused in practice, user to user interaction, distributed problem solving and dialogue which could generate new forms of knowledge.

In terms of interest for a given topic, the present research provides evidence that YouTube does not affect it in the long term. Neither did YouTube affect the target of feelings expressed by the evaluation participants. Despite of the multiple functions available to communicate with others, the emphasis on self-feelings by the participants might be an indication of YouTube nurturing individualism. Moreover, there was some evidence that YouTube is not a good starting point for education of a beginner.

One characteristic of some of the videos employed in the recommendation system is that they aid practical knowledge to be applied to everyday life, as the video "topics get broad and encompass multiple ideologies and identities" (Horton, 2003). In such regards, the proposed recommendation system acts as an automatized gatekeeper based in research done by a human gatekeeper on videos chosen by yet another automatized gatekeeper (YouTube's algorithm) and many other human gatekeepers (those who watched, liked, disliked and/or commented on the videos). In all the steps leading to the educational intervention, human participation has been crucial.

It is tempting to develop a technological solution that could potentially be spread using the existing infrastructure with minimal cost and effort. However, by proposing a recommendation system paired with a human intervention, several issues can be addressed simultaneously. An increasing dependence on technological devices does not only translate in the extraction of non-renewable Earth systems, but also fosters individualism.

As could be appreciated in Chapter IV of the present study, individualism is one of the reasons why designers feel disempowered and fail to adopt sustainable design. Moreover, using only multimedia materials could foster the experience of double reality (Norgaard, 2014), which is a condition where information held in cognitive awareness cannot be integrated into everyday life without threatening its integrity. This would prompt to reaffirm former (negative) views on sustainable design, mitigating interest and concrete actions related to the topic.

The present results can not claim to make lasting impacts on participants of the educational intervention. Instead, they reveal the possibilities of re-thinking technology in educational contexts through the lens of sustainable design, while also confronting the power dynamics between developed and developing countries. They provide evidence of how emotions and interest operate related to sustainable design in two specific design communities.

The usage of video content made sustainable design real and applicable in three ways: a) Animations explaining the three dimensions of sustainable design and life cycle assessment used images to represent abstract concepts effectively for beginners, who can have difficulties grasping complex abstractions; b) The testimony, methodologies and work of real designers grounded the concepts into concrete products and services; and c) The actions and reactions of designers and users of sustainable products and services are shown. In the case of participants who were already familiar with sustainable design, this helped reaffirm their commitment, as evidenced in their constant attention on the videos despite reporting they felt bored.

In sum, such communication techniques can humanize and translate complexity, potentially being an impactful first approach or reminder of what sustainable design can accomplish. Therefore, interest on sustainable design would be either maintained (in case of expert viewers) or increased (in case of novice viewers); while concrete examples directly related to their expertise field motivated some designers to adopt and/or realize the potential of sustainable design in their practice, as reported in surveys 2 months after the intervention.

Answering to the question by Romero and Ventura (2013) on which other affective states or student choices should we track besides interest and boredom, the present study proposes the congruency between the specialization field of the student and the audio-visual materials; and to respect and embrace cultural differen-ces in terms of emotional experience. In contrast to Hart & Nisbet (2012), the present evaluation provides more evidence that objectivity does not always polarize people, as could be noted among creativity-oriented individuals.

23 CONCLUSIONS

This section has proposed an educational intervention to teach sustainable design. The conclusions are as follows:

1.1 By focusing in human role models and showing the beneficial effects of sustainable design in humans, videos can foster the adoption of pro-environmental behaviours in the design process.

1.2 While videos illustrating complex and/or subjective concepts made sustainable design more understandable for novice viewers, videos showing designers, concrete methods, and products and services, helped expert viewers to acquire new ideas or reaffirm behaviours that they have adopted already.

1.3 There is some indication that congruency between the design field of the viewer and the video might have been more relevant than elicited feelings to enhance the practice of sustainable design.

2.1 According to the surveys, while YouTube users showed a decline of interest in sustainable design 2 months after watching videos, the recommendation system users kept practicing sustainable design.

2.2 Based on system precision and recall and observations during the evaluation, English speaking viewers were exposed to content from more varied locations, while Spanish speaking viewers were exposed to more local content, in line with needs discussed in section 19.2. As result, their definitions of sustainable design were more integrated and complex 2 months after the intervention.

3.1 According to section 19.2 and observations during the evaluation, while both English and Spanish speakers have similar systemic, psycho-social and formal needs related to sustainable design, they also have different requirements:

   a. Mitigation of individuality, fear and pain management are more relevant for English speakers.
   b. Spanish speakers require more information on local resources and can tolerate more negative emotions, as long as they are managed adequately after watching videos.

3.2 The implementation intentions part of the intervention further supported and personalized the experience, making it more relevant for the participants and correcting some wrong assumptions based on the videos.

4.1 Based on eye-tracking and surveys, Asian participants had an overall westernized conceptualization of sustainable design, also showing a decline on the concept of circular time. However, inclusion of living beings in the videos apparently aided their comprehension of the topic.

Limitations of the system include adding more videos, due to the wide range of analysis that were required to create video databases. Later versions could include a module to suggest videos for human experts to evaluate them. Automatizing other processes within the system (e.g. semantic, sentiment analyses and keywords detection) would also accelerate databases updates.

Another relevant aspect would be to incorporate videos in other languages. Particularly in the case of China and India, it would be advisable to develop the educational intervention for viewers from these nationalities.

Finally, testing the educational intervention with more human subjects is highly recommended. Incorporating signed commitments and/or small reminders like stickers or wearables (based in McKenzie-Mohr, 2000) would be valuable additions to the educational intervention. Furthermore, integrating community strengthening and political organization (and participation) could be explored in co-design exercises.

Given that there is some indication that multi-tasking is frequent in Spanish speakers, and that concentration rate among technology users is decreasing (Wolf, 2018), the proposed educational intervention could also be used to improve concentration time of users by gradually increasing the videos watching time or the quantity of videos.

CHAPTER VI:

GENERAL DISCUSSION AND CONCLUSIONS

"I believe in design as a part of our lives and not as an elitist label. An approach or object that pares down to making our lives better and hearts lighter and brighter are the best design solutions."

-Anu Tandon Vieira (2017)

24. GENERAL DISCUSSION

A complex topic like sustainable design is bound to cause a variety of reactions, partly due to the contradictions in its context. Such contradictions reinforce the perception of differences between stakeholders, instead of focusing on common ground and objectives. In the present section, contradictions found throughout the present research will be discussed.

24.1 The Contradictions Of Sustainable Design

Firstly, a distinction between the diffusion of theory and practice in terms of sustainable design should be made. Which could be considered more important? The quick answer would be that both are equally important, but if we take into consideration literature reviews and findings of the present study, WEIRD countries tend to be more focused on theory while non-WEIRD countries are more focused on practice. A combination of ideologies, gender dynamics, legislation, economic development, educational programs, consumer demands and communication patterns has contributed to shape the flows of sustainable design as we know them.

The result is that the theory of sustainable design is better disseminated than the many products and services that exist, which also contributes to the perception of sustainable design as a niche field, and to the lack of enthusiastic interest on it. Red Wing (2018) mentioned that "there's a lot of fear of uncertainty in Western culture; therefore definitions are cornerstone for *understanding* but when you want definitions you're lacking appreciation, aesthetics…". In other words, knowledge based solely on rationality misses Kansei, contributing to a fragmented understanding of design.

In such regards, the proposed education intervention aimed to balance the amount of theory and practice available. In the case that the recommendation system user watched only theory videos, the human guide discussed concrete examples and vice versa.

Design has been considered a discipline for around a hundred years thanks to the Bauhaus, but with such a rational and scientific approach, definitions and methodologies also won relevancy over the practice itself. Latest efforts to understand design in more integral terms include emotional design (related to Kansei design and discussed in section 4.3). However, there is a latent danger of limiting our understanding by extending design considerations to humans but not to animals, plants and landscapes. Failing to perceive and consider the Earth as a complex living system is a relevant obstacle for the understanding and dissemination of sustainable design.

There is evidence that the general tendency to care less for nature is learned throughout life (e.g. Neldner, 2018), which implies that appreciation for nature can be relearned. With environmental education mostly targeted to children, and with the limited nature related courses in some art, design and engineering schools despite their demonstrated benefits (see Alawad & Mahgoub, 2014; Mahgoub & Alawad, 2014), a need to reconnect designers to other living beings emerges. Once again, in the case that a user only watched videos about concrete design objects, the human guide can complement that vision with further discussion, evoking any beneficial contact with nature that the user might have had in the past.

This brings us to the next contradiction: by highlighting the human impacts and links with nature (as in several of the top popular videos found in the present study), and furthermore, by assigning human characteristics to nature, people are shown to care more about it (e.g. Horowitz & Beckoff, 2007; Tam et al., 2013). Numerous campaigns have used anthropomorphized animals and plants to connect with disengaged audiences, while some governments around the world have granted human rights to nature. This has antecedents in how animistic religions anthropomorphize natural phenomena and non-human living beings.

Nevertheless, anthropomorphizing nature ultimately relays on an artificial notion of humans as the epitome of biological evolution, intellectual and moral development. Hence, any "humanlike" being should have the same rights as us, and any menace to our survival (and to the "others" who sustain us), should push us to act. This is an egoistic and utilitarian approach to Sustainability, which leaves the needs of other living beings and the Earth in second place, reaffirming artificial divisions between "us" and "them".

Saito (1998) argues that we should learn to perceive and attribute value to nature just because it exists. This would be the only necessary reason to recognize its rights. Once such a practice becomes unconscious, concern for the environment would be strengthen (Schultz et al., 2004). In such regards, there are examples on how to attribute personality to nature in a non-human way in some Latin American cultural products (Wylie, 2016).

Designers, particularly those in early educational stages, are particularly suited to re-link to nature in a variety of ways. Such encounters can be first framed as creative exercises, while an eventual more structured teaching of practical applications and formulation of rules (e.g. zero waste in prototype development) could aid sustainable design diffusion and interest. In such regards, the human guidance included in the educational intervention addresses the particular needs of the designer, exploring ideas that they find useful but also fun.

Beyond other living beings, we also can identify the contradiction of women representation in sustainable design. Meanwhile characteristics traditionally attributed to women such as kindness, cooperation and care elicited positive reactions among the YouTube videos commenters, English comments rarely mentioned women designers by name. Global power structures ensure that professional designers and professors remain mostly male.

Hence, classic designers like Papanek and McDonough are still well known and cited, while a swarm of mostly anonymous women practice diverse types of sustainable design, often through techniques that have been passed on and improved from one generation to the other. They don't need to know the definition of sustainable design or even call their design in a specific way. Through such practice, some contribute to their societies, earn their economic freedom, and their intellectual and physical emancipation.

What designers enclosed in an office on the top of a tall building in the heart of a busy city often forget is that by designing, they are not only transforming external objects and energy. They are not only pleasing a client and considering the needs of users. They are also shaping themselves. Therefore, hand labour, demeaned by many in favour of intellectual labour, has its rightful place in the present and future of design.

By extension, it is also relevant to remember the importance of the demystification of technology, and to be conscious of what convenience and/or reliance on it is hiding (Posner, 2018). In contrast, hand labour and the resulted products bring upfront the designers, cultures and overall context that enable their sustained existence. A balanced combination of both could potentially push sustainable design towards one of its main immediate challenges, which is dealing with uncertain futures. That is why the recommendation system includes videos that highlight both technological and handmade design. In case the user only watches technological solutions, the human guide can complement that vision with handmade examples, and so on.

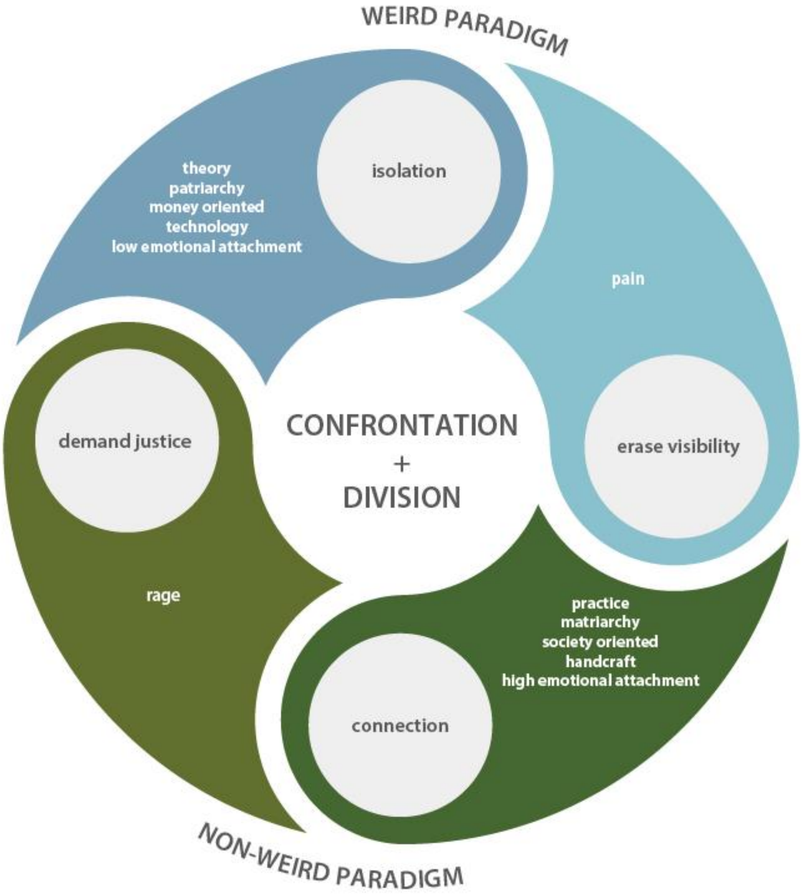
Next, we have a largely unexplored contradiction related to sustainability, the relationship of humans with designed products and services. It is said that one of the problems of consumerism is that users do not get attached to their gadgets, probably more influenced by peer pressure than by personal choice (see Abdallah et al., 2018). Usually, it does not matter how well designed a product/service is, many of them eventually become obsolete and prone to be replaced. What would happen then, if a more energy saving/ethical product comes out and the user is already emotionally attached to the former version?

Another issue is that a product/service designed sustainably might not change through time, but the user might. An example would be a baby cradle that morphs into a childhood bed. Maybe when the child grows up the cradle-bed can be stored for future generations, but what happens if the adult does not want to raise children or is not surrounded by people who might need a cradle-bed?

This is where bio degradable materials and easily disposable structures that can be reintegrated to nature cycles come to play. The results of such considerations could be called *materials/designs in perpetual movement*. However, if the user is emotionally attached to such products/services, the pain of watching them disappear and become something different might be severe. Such a design would mirror the ever-changing nature of human relationships and the seasons, probably awakening other pains related to loss. Thus, the designer would have two possible choices: create more emotionally attaching products/services regardless of the user's pain; or to aim to change the user's perception to realize that a) every created object has a value, and b) that the product/service and the user themselves are bound to change, to be in perpetual movement.

In sum, contradictions of sustainable design are reflected in the present research results, as can be appreciated in Figure 74. Non-WEIRD communities could be nominated through the concept of *comunalidad* (communality) described by Díaz (2007) and Martínez Luna (according to Barrera Pineda, 2017). Comunalidad is the resistance to the WEIRD paradigm (Temper, 2018), born from the erasure of non-WEIRD communities and eliciting *digna rabia* (rightful anger).

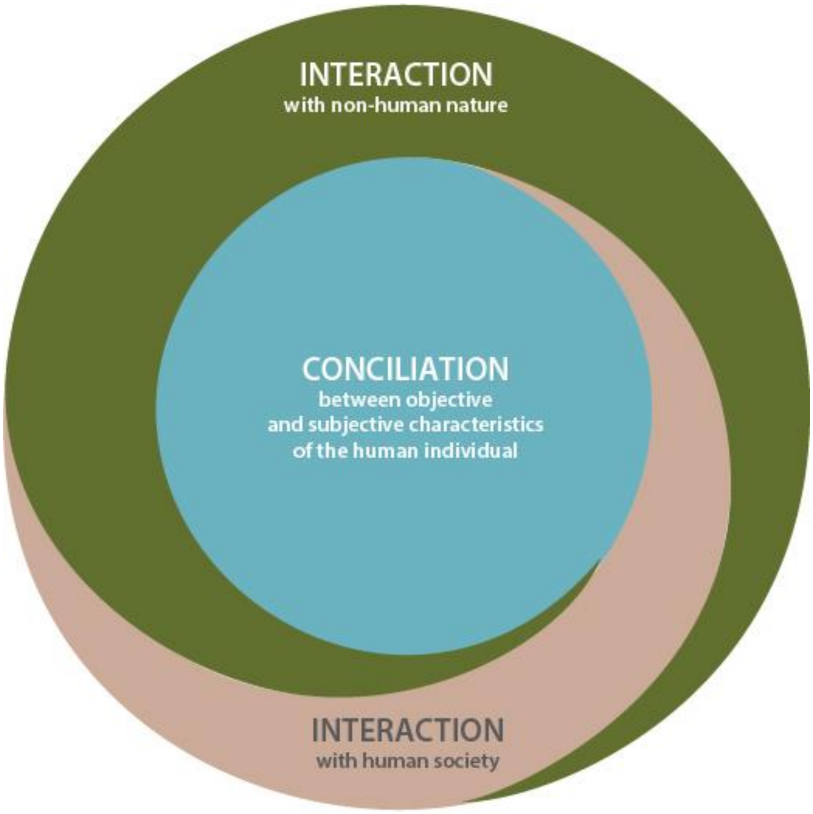
Figure 97. Contradictions of Sustainable Design,
as Reflected in WEIRD and non-WEIRD paradigms



24.2 Towards A Better Designer Aided By Interest On Sustainable Design: Proposal Of The KAPAC Paradigm

What James (2014) calls ontological friction, and Fry et al. (2015) and Tonkinwise (2018) call hypocrisy vs. experimentalism should cease to be framed as irreconcilable aspects in pursue of sustainability. Rather, through the lens of ecoambiguity found in design, we become aware that we exist in a place of ambivalence, which has to be confronted, understood, accepted and assimilated at the personality level, community level and environmental level. Figure 98 represents this transformative process, where the designer stops perceiving themselves as individuals and extend their conscience and interest. It would be an assimilation of Ying and Yang, of the good and bad, which would enable the psychological restoration of the designer. They would hence move on and change their own paradigms to transform themselves and thus be perpetually in motion.

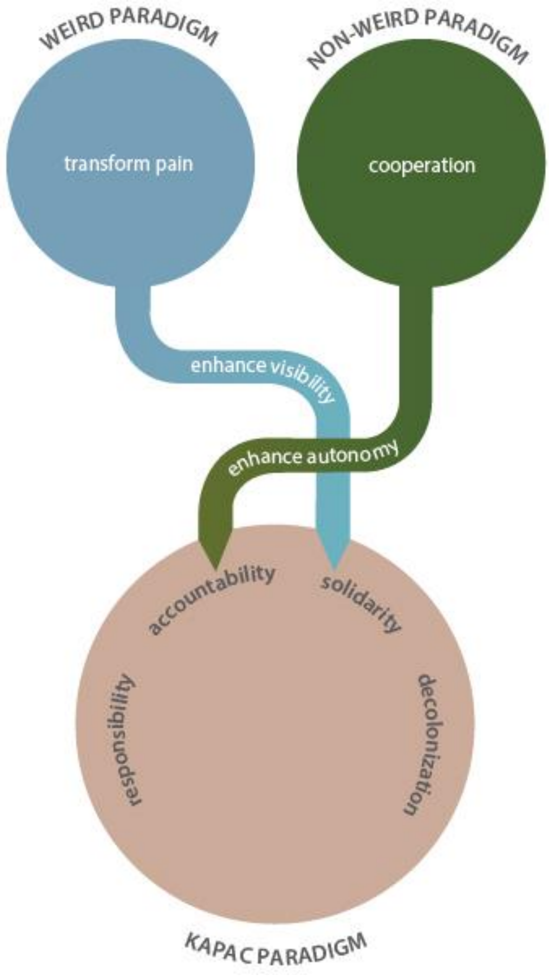
Figure 98. Designer's Transformative Process



For some designers, the process would have similarities to a spiritual awakening; while a non-religious person can entail it as a paradigm change in terms of intellect, imagination, sensibility and will (Findeli, 2001). For others, it would entail unexpected and potentially painful encounters, fuelled by *bio speculative design*. Some of the changes will be inconvenient. This is where a constantly curious and motivated mind is relevant. This is where having encouraging peers and a healthy social environment is relevant. This is where constant contact with other living beings and nature is relevant. This is where being capable of thinking, feeling and practicing design that reflects the best of our values is relevant.

Figure 99 represents such values. As articulated by Bora (2016a) "in the name of unifying the symbolic and the material, our efforts take the form of a symbolic act that recovers aspects of life that have been suppressed by (classical) theory". Thus, an anti-industrial design or provincial industrial oriented design would foster conviviality throughout the design process, according to Escobar (2018).

Figure 99. Values of Sustainable Design synthetized in the KAPAC Paradigm



For the sake of communication with WEIRD paradigm holders, the acronym KAPAC is being proposed. It means Knowledge that is Artisanal, Plural, Abundant and Communal; Knowledge not necessarily acquired through official institutions; Artisanal in terms of acts augmented/extended through traditional and modern technology; Plural because it embodies the many voices it serves; Abundant because it preserves diversity to foster prosperity for all life; and Communal because communities are at the centre of its governance.

These principles take us to a process based on epistemological decolonization (Botero, 2013; Echeverría, 2015), where it is assessed which presupposed concepts are we moved by and how we apply them to everyday life.

In such a scenario, thinking, feeling and doing are simultaneous, while autonomy is understood as the ability to self-organize.

Ultimately, the KAPAC paradigm would enable our "KAPACities" to become better designers. Our role would be to create social and cultural infused experiences, incorporating a more intangible and time infused dimension to products and services which would foster a fairer distribution of energy flows and systems. The impermanent should be mourned but also celebrated, as animistic religions in Africa, Asia, Latin America and elsewhere still do.

Nevertheless, more research will be necessary to understand the adequate level of attachment to products/services combined with the right level of change in them within each context. We should design not to transform the world, but design as part of the world transforming itself (Gatt & Ingold, 2013).

Examples of managing pain in WEIRD communities and reorienting them towards the KAPAC paradigm could be young consumers and their interaction with living space in Argentina (Gonzalez Fernandez & Fernandes Moores, 2014). Another example from Japan is the Kamado Project. After researching traditional pottery and stoves, a team of designers created portable rice cookers to cook rice for victims of environmental disasters, which confronts and conciliates different communities at a time of loss (Kamado Project, 2018).

Probably the most visible examples of radical design transformations (which take a long time and usually go unnoticed) towards the KAPAC paradigm can be found in geopolitical borders. The Ecocity Project in Famagusta aims to reunite the forbidden zone of Varosha with the rest of the city, driving cooperation between Greek and Turkish Famagustians, who have been torn apart by the Turkish occupation of 1974 (Famagusta Ecocity Project, 2018).

The Mexican-American border is yet another example of material integration of the KAPAC paradigm. The boundary has been subject of disputes for centuries. Some portions have been clearly marked and defended by humans, while some obey the demarcation of the Rio Grande river and the Colorado River Delta. The border also crosses the Chihuahua and Sonora deserts. Several plants, insects and animals migrate and interact between the two sides (e.g. Curtin, 2002). Recently, the geopolitical issue of the border is how it enables illegal immigrants and civil war refuges to arrive to the U.S. As much as the American government discourse is to physically divide the two countries, this remains infeasible.

Meanwhile, for those creative humans who inhabit and/or interact with borders, this place can be conceived as an open wound that has brought compensations and joy, offering a reflection of their own "shifting and multiple identity", but also expressing "aesthetics of resistance", challenging the boundaries of nation-state (Anzaldua, 1987). Hence, we can see in the work of such designers, how the confrontation and assimilation of pain and multiple contradictions that range from the individual to the environmental fuel a creative and fluid zone where paradigms are broken (Taylor, 2014). However, such encounters can be enabled practically anywhere in the world.

Going back to Meadows (2018), the power to transcend paradigms relays in being conscious of a space that humans can not fully comprehend, that is beyond rationality. We are limited and thus we should remain flexible and open to different ideas... the creativity so coveted by designers. It is in this space beyond paradigms where the educational intervention to foster sustainable design interest was born. Instead of only employing technological methods, a thorough research methodology involving qualitative analysis was employed. Instead of applying conventional algorithms just as they are, subjective measurements were included in the video recommendation system. Instead of proposing only a technological solution, it was paired with human guidance. Although imperfect, the educational intervention materializes a path to increase interest in sustainable design on unconventional terms.

24.3 Beyond Sustainable Design

In a world in perpetual movement, how could methodologies and material integration of a designer improve? How could we upscale and go beyond the KAPAC paradigm? The Design Justice principles (Design Justice Network, 2016) are a good starting point, although they are more focused in human communities and generalize the denomination of non-human beings as "Earth". Instead, designers would consider the following aspects:

1. Reframe "communities" as all living beings and habitats in which we depend.
2. Centre the voices of those who are directly impacted by the whole design process and not only the outcomes.
3. Not make distinctions between the living Earth and each other.

4. Not seek full control but a more decentralized, horizontal and balanced control.
5. Design for redistribution wherever human systems are blocking natural flows.
6. Transcend paradigms.

With such considerations, designers would be steered towards visualizing not only humans, but other living beings and the environment as a part of life, enhancing the impact of *bio speculative design* and design justice. Such steps would contribute to leave the Anthropocene behind and enter what Swimme and Berry (1992) call *the Ecozoic Age*. Because this term is scientifically sound but difficult to be assimilated by human audiences, I am recovering the term *biophilia* (love for all life), which encompasses the planet and all its living beings. Hence, a Biophilic Age would ideally be characterized by an emotional attachment to all the creatures of the world (even beyond, considering organic molecules found elsewhere in the universe), and a sustained effort to preserve all life.

Designers can be a part of the Biophilic Age. Ford and Norgaard (2018) define our task as "building bridges from old ways of being to new ones", which would also be safe, beautiful and pleasurable. This is where *Transition Design* emerges, proposed by Terri Irwin in Carnegie Mellon University (2015). Called *Disoñar* in Spanish (Duque López, 1996), this type of design is based on the view that even change governed by outdated structures is prone to unexpected outcomes. As mentioned before in the present research, designers should be prepared to deal with uncertainties. Therefore, we should "imaginatively yet critically speculate on all possibilities, preferable and nonpreferable" (Tonkinwise, 2018).

This perspective fortifies the time dimension of design and would aid us to detect bad design decisions even before they are brought for discussion. Further, we should never forget that the process has to go hand in hand with thinking-feeling with the living planet (Escobar, 2018), and ultimately, with all life.

25 GENERAL CONCLUSIONS

The present research investigated sustainable design in Video Social Networks, uncovering several objective and subjective aspects that either motivate or demotivate the adoption of the afore mentioned design, to propose an educational intervention to foster interest in the topic. Main findings include:

1. The materialization of a more sustainable technology for watching videos should involve humans and humanizing the audio-visual materials employed.
2. Formal, politico-economic, socio-cultural, and psychological features favour the interest on theories related to sustainable design, while practice and the contexts where it is more frequently practiced are made less visible.
3. Positive views of sustainable design are related to an acceptance of complexity, interdisciplinarity, problem-solving mindset, community values, and personality characteristics such as kindness and cooperation.
4. Main barriers for sustainable design include people, society, politic-economical system, lack of effectiveness and lack of adequate information to practice it.
5. Moderately positive emotions and a high interest in sustainable design might enhance its practice.
6. However, congruency between the design field and information/education received might be more relevant than interest and emotions related to the practice of sustainable design.

Network related methodologies offer a powerful alternative to understand dynamics between multiple factors influencing the perception of a topic, particularly if such topic is as complex as sustainable design. These methodologies also deepen our understanding of cultural contexts, their contrasts and potential bridges between them. In such regards, the present study had a transcultural nature, covering a broad spectrum of factors related to sustainable design interest. It can be concluded that investing time in thorough cross-sample studies that employ quantitative and qualitative methods can deepen our understanding of objective and subjective aspects impacting design theory and practice. Hence, educative methods better aligned with the challenges and needs of designers immersed in a complex world can emerge of such analysis.

The position of the present research consisted on extending social sciences (network and qualitative) methods towards the analysis of design practices, thoroughly revising theoretical and methodological frameworks to integrate sustainability through feminist technology studies. Environmental psychology was employed to understand design related endeavours; and network, data science and eye-tracking were employed to empirically corroborate the assumptions.

An educational intervention was developed to reconfirm inferences about interest. Some relationships between feelings, interest and practice related to sustainable design were uncovered, although not all of them could be generalized due to the small number of participants. However, contributions to the field of environmental psychology, mostly focused on general people's behaviours but not on creative people's behaviours, were offered. The present study also contributed to the field of environment connected to Kansei, which again, has been mostly focused on general people but not in creative people.

The present research was mainly focused on visual aspects that affect the perception of sustainable design. There was some indication that music could also affect positively and negatively the perception of the viewers. Therefore, this topic remains an open opportunity for further research. Future analysis can also explore superficially covered aspects like the interaction between religion, language and design. Individual characteristics that might be also influencing sustainable design interest such as curiosity, adventurousness and risk aversion could be explored as well. The role of design field in the adoption of sustainable design should be further confirmed. Moreover, the social influence of design related behaviours in collective educational scenarios, and co-creation in such spaces were not explored in detail.

The present work ultimately aims to push designers from their comfort zone and explore the creative possibilities of design as politics (understood as decision making), influenced by multiple objective and subjective factors according to multiple contexts. Ultimately, a rise on political collective efficacy among designers would be the top determiner in practicing a better sustainable design. As Hanisch, Firestone, Koedt (1970) and Enloe (2014) would assert, the personal is political and the political is personal. It is a choice that will determine the sustainability of life.

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FIGURES LIST

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ANNEXES

Annex 1. Videos Per Country

Country	# of SDEN Videos	# of SDES Videos	Country	# of SDEN Videos	# of SDES Videos
Argentina	1	93	Moldova	1	0
Australia	130	0	Netherlands	49	0
Austria	6	0	Newzealand	17	0
Bangladesh	1	0	Nicaragua	0	1
Belgium	7	0	Nigeria	2	0
Brazil	2	1	Niue	1	0
Bolivia	0	2	Norway	3	0
Cambodia	1	0	Oman	1	0
Canada	99	0	Pakistan	5	0
Chile	2	45	Panama	0	9
China	7	0	Paraguay	0	5
Colombia	1	180	Peru	3	31
Costarica	0	11	Philippines	13	0
Czechrepublic	2	0	Poland	1	0
Denmark	20	0	Portugal	2	0
Dominicanrepublic	0	5	Qatar	2	0
Ecuador	0	11	Romania	2	0
Egypt	6	0	Rusia	1	0
Elsalvador	0	2	Samoa	1	0
Estonia	2	0	Serbia	1	0
Ethiopia	2	0	Singapore	20	0
Finland	11	0	Slovenia	2	0
France	16	2	Southafrica	14	0
Germany	20	3	Southkorea	7	0
Greece	5	0	Spain	17	239
Guatemala	0	7	Srilanka	7	0
Honduras	0	2	Sudan	1	0
Hongkong	10	0	Sweden	17	0
Hungary	1	0	Switzerland	9	0
Iceland	2	0	Syria	1	0
India	44	0	Taiwan	1	0
Indonesia	5	0	Tanzania	1	0

Iran	1	0	Thailand	12	0
Ireland	21	0	Tokelau	1	0
Israel	7	0	Trinidadandtobago	1	0
Italy	19	1	Turkey	3	0
Japan	13	0	Uganda	3	0
Kenya	1	0	UK	241	0
Latvia	2	0	Unitedarabemirates	8	0
Lebanon	2	0	Uruguay	0	3
Lithuania	1	0	US	862	11
Luxembourg	2	0	Venezuela	0	12
Malaysia	10	0	Vietnam	4	0
Mauritius	1	0	Unclear	632	287
Mexico	0	113	TOTAL	2452	1076

Annex 2. SDEN most viewed videos

Video Title	Country	Design Area	Uploader	Speaker	Univ. related	Channel	# of views
GreenBo*******	us	mixed	business	people	0	greenbo***	6,097,544
15 Icon*******	undisclosed	architecture	business	none	0	EcoCont*******	1,306,969
The Sto*******	us	industrialdesign	education	research	0	storyof*******	1,150,926
Walmart*******	undisclosed	industrialdesign	media	people	0	GeoBeat*****	1,105,190
ecochai*******	denmark	industrialdesign	people	none	0	Line Ho**	911,995
10x 10 *******	uk	architecture	professors	professors	1	thehypn*****	815,424
Hankook*******	australia	industrialdesign	business	none	0	Hankook*******	789,548
Elon Mu*******	us	industrialdesign	media	business	0	TED	623,975
Green f*******	samoa	architecture	media	none	0	TVGOODN*****	621,326
Low cos*******	canada	architecture	education	edupeoplemix	1	aircvid******	597,078
Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	# of views
10x 10 *******	uk	architecture	professors	professors	1	thehypn*****	815,424
Low cos*******	canada	architecture	education	edupeoplemix	1	aircvid******	597,078
Jacque *******	us	general	designers	designers	1	Jacque*******	192,703
Car-des*******	us	industrialdesign	media	professors	1	Autowee****	159,853
Design *******	undisclosed	mixed	undisclosed	students	1	haoands**	143,378
BaleHau*******	uk	architecture	university	research	1	Univers*******	140,905

Sustain*******	undisclosed	industrialdesign	students	people	1	James S*******	117,439
Module *******	india	architecture	university	professors	1	nptelhr*	112,985
Stanfor*******	undisclosed	industrialdesign	business	students	1	Autodes*	107,454
Student*******	us	industrialdesign	university	students	1	Stanfor*	105,699

Annex 3. SDEN Most Liked Videos

Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	Number of likes
GreenBo*******	us	mixed	business	people	0	greenbo***	11,175
Elon Mu*******	us	industrialdesign	media	business	0	TED	9,099
The Sto*******	us	industrialdesign	education	research	0	storyof*******	8,614
The Ven*******	undisclosed	general	education	people	0	3online*******	5,229
Hankook*******	australia	industrialdesign	business	none	0	Hankook*******	5,007
Donald *******	us	mixed	media	research	0	TED	3,923
How Gra*******	us	general	media	media	0	DNews	3,552
Jacque *******	us	general	designers	designers	1	Jacque*******	3,541
Green f*******	samoa	architecture	media	none	0	TVGOODN*****	3,523
10x 10 *******	uk	architecture	professors	professors	1	thehypn*****	3,224
Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	Number of likes
Jacque *******	us	general	designers	designers	1	Jacque*******	3,541
10x 10 *******	uk	architecture	professors	professors	1	thehypn*****	3,224
Design *******	us	general	media	professors	1	TED	1,338
Low cos*******	canada	architecture	education	edupeoplemix	1	aircvid******	1,168
Car-des*******	us	industrialdesign	media	professors	1	Autowee****	833
TEDxWar*******	austria	mixed	media	professors	1	TEDx Ta***	684
Bjarke *******	sweden	architecture	university	designers	1	KTH Ark*******	533
Emergen*******	japan	architecture	media	professors	1	TEDx Ta***	494
Designin*******	us	architecture	media	students	1	The Eco******	455
Douglas*******	us	architecture	university	business	1	case	454

Annex 4. SDEN Most Disliked Videos

Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	# of dislikes
The Sto*******	us	industrialdesign	education	research	0	storyof*******	496
GreenBo*******	us	mixed	business	people	0	greenbo***	319
Walmart*******	undisclosed	industrialdesign	media	people	0	GeoBeat*****	318
10x 10 *******	uk	architecture	professors	professors	1	thehypn*****	230
The Ven*******	undisclosed	general	education	people	0	3online*******	171
Graham *******	us	general	media	designers	0	TED	142
Free En*******	undisclosed	mixed	designers	designers	0	Mario G****	98
James K*******	us	architecture	media	people	0	TED	96
VertiGro*******	undisclosed	architecture	undisclosed	none	0	RustyBo***	96
Hankook*******	australia	industrialdesign	business	none	0	Hankook*******	91
Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	# of dislikes
10x 10 *******	uk	architecture	professors	professors	1	thehypn*****	230
Low cos*******	canada	architecture	education	edupeoplemix	1	aircvid******	89
Jacque *******	us	general	designers	designers	1	Jacque*******	64
Design *******	us	general	media	professors	1	TED	48
Student*******	us	industrialdesign	university	students	1	Stanfor*	48
Car-des*******	us	industrialdesign	media	professors	1	Autowee****	26
TEDxWar*******	austria	mixed	media	professors	1	TEDx Ta***	25
Design *******	undisclosed	mixed	undisclosed	students	1	haoands**	22
Episode*******	us	industrialdesign	business	students	1	Shell #*******	19
Douglas*******	us	architecture	university	business	1	case	15

Annex 5. SDEN Most Commented Videos

Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	Number of comments
The Ven*******	undisclosed	general	education	people	0	3online*******	2,300
GreenBo*******	us	mixed	business	people	0	greenbo***	1,659
Elon Mu*******	us	industrialdesign	media	business	0	TED	1,517
The Sto*******	us	industrialdesign	education	research	0	storyof*******	1,456
10x 10 *******	uk	architecture	professors	professors	1	thehypn*****	940
Jacque *******	us	general	designers	designers	1	Jacque*******	872

How Gra*******	us	general	media	media	0	DNews	754
Donald *******	us	mixed	media	research	0	TED	734
James K*******	us	architecture	media	people	0	TED	719
How a B*******	uk	architecture	media	people	0	Journey*******	691
Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	Number of comments
10x 10 *******	uk	architecture	professors	professors	1	thehypn*****	940
Jacque *******	us	general	designers	designers	1	Jacque*******	872
Student*******	us	industrialdesign	university	students	1	Stanfor*	179
TEDxWar*******	austria	mixed	media	professors	1	TEDx Ta***	153
Design *******	us	general	media	professors	1	TED	147
Low cos*******	canada	architecture	education	edupeoplemix	1	aircvid******	133
Design *******	us	architecture	media	students	1	The Eco******	126
Fuel Ef*******	us	industrialdesign	media	students	1	Enginee*******	113
Car-des*******	us	industrialdesign	media	professors	1	Autowee****	77
A Propo*******	us	architecture	students	none	1	Sam Jr.******	47

Annex 6. Spearman Correlation on SDEN YouTube Metrics

			viewcount	likecount	dislikecount	commentcount
	viewcount	Correlation Coefficient	1.000	.837**	.567**	.614**
		Sig. (2-tailed)		0.000	.000	.000
		N	2452	2388	2388	2444
	likecount	Correlation Coefficient	.837**	1.000	.549**	.646**
		Sig. (2-tailed)	0.000		.000	.000
		N	2388	2388	2388	2384
	dislikecount	Correlation Coefficient	.567**	.549**	1.000	.515**
		Sig. (2-tailed)	.000	.000		.000
		N	2388	2388	2388	2384
	commentcount	Correlation Coefficient	.614**	.646**	.515**	1.000
		Sig. (2-tailed)	.000	.000	.000	

		N	2444	2384	2384	2444
**. Correlation is significant at the 0.01 level (2-tailed).						

Annex 7. SDEN Mann-Whitney U Test

Variable		N	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
viewcount	notuniversityrelated	1051	1263.32		
	universityrelated	1401	1198.88		
	Total	2452		697525.500	.026*
likecount	notuniversityrelated	1018	1197.84		
	universityrelated	1370	1192.01		
	Total	2388		693925.500	.836
dislikecount	notuniversityrelated	1018	1231.13		
	universityrelated	1370	1167.28		
	Total	2388		660040.000	.002*
commentcount	notuniversityrelated	1047	1264.83		
	universityrelated	1397	1190.77		
	Total	2444		687009.500	.001*
designareaArchitecture	notuniversityrelated	1051	1278.40		
	universityrelated	1401	1187.56		
	Total	2452		681674.500	.000*
designareaGeneral	notuniversityrelated	1051	1214.81		
	universityrelated	1401	1235.27		
	Total	2452		723939.000	.254
designareaGraphicdesign	notuniversityrelated	1051	1223.33		
	universityrelated	1401	1228.88		
	Total	2452		732891.000	.565
designareaIndustrialdesign	notuniversityrelated	1051	1187.32		
	universityrelated	1401	1255.89		
	Total	2452		695044.000	.000*
designareaMixed	notuniversityrelated	1051	1228.64		
	universityrelated	1401	1224.89		
	Total	2452		733974.000	.831
uploaderareaBusiness	notuniversityrelated	1051	1345.96		
	universityrelated	1401	1136.88		

	Total	2452		610670.500	.000*
uploaderareaDesigners	notuniversityrelated	1051	1253.66		
	universityrelated	1401	1206.13		
	Total	2452		707682.500	.000*
uploaderareaEducation	notuniversityrelated	1051	1312.96		
	universityrelated	1401	1161.64		
	Total	2452		645352.000	.000*
uploaderareaEvents	notuniversityrelated	1051	1224.83		
	universityrelated	1401	1227.75		
	Total	2452		734473.000	.454
uploaderareaGovernment	notuniversityrelated	1051	1235.16		
	universityrelated	1401	1220.00		
	Total	2452		727120.000	.004*
uploaderareaMedia	notuniversityrelated	1051	1338.79		
	universityrelated	1401	1142.26		
	Total	2452		618208.000	.000*
uploaderareaPeople	notuniversityrelated	1051	1277.31		
	universityrelated	1401	1188.38		
	Total	2452		682820.000	.000*
uploaderareaProfessors	notuniversityrelated	1051	1203.50		
	universityrelated	1401	1243.75		
	Total	2452		712052.500	.000*
uploaderareaResearch	notuniversityrelated	1051	1237.33		
	universityrelated	1401	1218.38		
	Total	2452		724845.500	.014*
uploaderareaStudents	notuniversityrelated	1051	1174.50		
	universityrelated	1401	1265.51		
	Total	2452		681573.500	.000*
uploaderareaUndisclosed	notuniversityrelated	1051	1258.49		
	universityrelated	1401	1202.50		
	Total	2452		702607.000	.000*
uploaderareaUniversity	notuniversityrelated	1051	855.50		
	universityrelated	1401	1504.82		
	Total	2452		346304.500	.000*
speakerareaBusiness	notuniversityrelated	1051	1296.65		

	universityrelated	1401	1173.88		
	Total	2452		662501.500	.000*
speakerareaDesigners	notuniversityrelated	1051	1395.61		
	universityrelated	1401	1099.64		
	Total	2452		558495.000	.000*
speakerareaEducation	notuniversityrelated	1051	1229.66		
	universityrelated	1401	1224.13		
	Total	2452		732899.500	.261
speakerareaEdupeoplemix	notuniversityrelated	1051	1168.83		
	universityrelated	1401	1269.76		
	Total	2452		675616.500	.000*
speakerareaGovernment	notuniversityrelated	1051	1233.50		
	universityrelated	1401	1221.25		
	Total	2452		728871.000	.008*
speakerareaMedia	notuniversityrelated	1051	1234.83		
	universityrelated	1401	1220.25		
	Total	2452		727470.000	.003*
speakerareaNone	notuniversityrelated	1051	1294.98		
	universityrelated	1401	1175.13		
	Total	2452		664255.500	.000*
speakerareaOthersmix	notuniversityrelated	1051	1244.00		
	universityrelated	1401	1213.38		
	Total	2452		717837.500	.000*
speakerareaPeople	notuniversityrelated	1051	1316.97		
	universityrelated	1401	1158.63		
	Total	2452		641140.500	.000*
speakerareaProfessors	notuniversityrelated	1051	972.50		
	universityrelated	1401	1417.05		
	Total	2452		469271.500	.000*
speakerareaResearch	notuniversityrelated	1051	1253.15		
	universityrelated	1401	1206.51		
	Total	2452		708220.000	.002*
speakerareaStudents	notuniversityrelated	1051	1077.33		
	universityrelated	1401	1338.40		
	Total	2452		579449.500	.000*

countryArgentina	notuniversityrelated	1051	1227.17		
	universityrelated	1401	1226.00		
	Total	2452		735525.000	.248
countryAustralia	notuniversityrelated	1051	1206.99		
	universityrelated	1401	1241.13		
	Total	2452		715724.500	.002*
countryAustria	notuniversityrelated	1051	1225.83		
	universityrelated	1401	1227.00		
	Total	2452		735524.500	.637
countryBangladesh	notuniversityrelated	1051	1226.00		
	universityrelated	1401	1226.88		
	Total	2452		735700.000	.386
countryBelgium	notuniversityrelated	1051	1228.83		
	universityrelated	1401	1224.75		
	Total	2452		733774.000	.126
countryBrazil	notuniversityrelated	1051	1227.83		
	universityrelated	1401	1225.50		
	Total	2452		734824.500	.102
countryCambodia	notuniversityrelated	1051	1227.17		
	universityrelated	1401	1226.00		
	Total	2452		735525.000	.248
countryCanada	notuniversityrelated	1051	1216.66		
	universityrelated	1401	1233.88		
	Total	2452		725885.000	.080
countryChile	notuniversityrelated	1051	1226.67		
	universityrelated	1401	1226.38		
	Total	2452		736050.500	.838
countryChina	notuniversityrelated	1051	1225.33		
	universityrelated	1401	1227.38		
	Total	2452		734999.000	.444
countryColombia	notuniversityrelated	1051	1227.17		
	universityrelated	1401	1226.00		
	Total	2452		735525.000	.248
countryCzechrepublic	notuniversityrelated	1051	1226.67		
	universityrelated	1401	1226.38		

	Total	2452		736050.500	.838
countryDenmark	notuniversityrelated	1051	1229.33		
	universityrelated	1401	1224.38		
	Total	2452		733249.500	.271
countryEgypt	notuniversityrelated	1051	1224.67		
	universityrelated	1401	1227.88		
	Total	2452		734298.500	.194
countryEstonia	notuniversityrelated	1051	1227.83		
	universityrelated	1401	1225.50		
	Total	2452		734824.500	.102
countryEthiopia	notuniversityrelated	1051	1226.67		
	universityrelated	1401	1226.38		
	Total	2452		736050.500	.838
countryFinland	notuniversityrelated	1051	1223.33		
	universityrelated	1401	1228.88		
	Total	2452		732897.000	.097
countryFrance	notuniversityrelated	1051	1225.50		
	universityrelated	1401	1227.25		
	Total	2452		735173.500	.664
countryGermany	notuniversityrelated	1051	1228.17		
	universityrelated	1401	1225.25		
	Total	2452		734475.500	.517
countryGreece	notuniversityrelated	1051	1224.00		
	universityrelated	1401	1228.38		
	Total	2452		733598.000	.053
countryHongkong	notuniversityrelated	1051	1225.00		
	universityrelated	1401	1227.63		
	Total	2452		734648.500	.410
countryHungary	notuniversityrelated	1051	1226.00		
	universityrelated	1401	1226.88		
	Total	2452		735700.000	.386
countryIceland	notuniversityrelated	1051	1227.83		
	universityrelated	1401	1225.50		
	Total	2452		734824.500	.102
countryIndia	notuniversityrelated	1051	1223.16		

	universityrelated	1401	1229.00		
	Total	2452		732719.500	.379
countryIndonesia	notuniversityrelated	1051	1226.33		
	universityrelated	1401	1226.63		
	Total	2452		736050.000	.897
countryIran	notuniversityrelated	1051	1226.00		
	universityrelated	1401	1226.88		
	Total	2452		735700.000	.386
countryIreland	notuniversityrelated	1051	1235.83		
	universityrelated	1401	1219.50		
	Total	2452		726419.000	.000*
countryIsrael	notuniversityrelated	1051	1226.50		
	universityrelated	1401	1226.50		
	Total	2452		736225.000	1.000
countryItaly	notuniversityrelated	1051	1222.83		
	universityrelated	1401	1229.25		
	Total	2452		732371.000	.144
countryJapan	notuniversityrelated	1051	1228.17		
	universityrelated	1401	1225.25		
	Total	2452		734475.000	.422
countryKenya	notuniversityrelated	1051	1226.00		
	universityrelated	1401	1226.88		
	Total	2452		735700.000	.386
countryLatvia	notuniversityrelated	1051	1227.83		
	universityrelated	1401	1225.50		
	Total	2452		734824.500	.102
countryLebanon	notuniversityrelated	1051	1225.50		
	universityrelated	1401	1227.25		
	Total	2452		735174.500	.221
countryLithuania	notuniversityrelated	1051	1226.00		
	universityrelated	1401	1226.88		
	Total	2452		735700.000	.386
countryLuxembourg	notuniversityrelated	1051	1227.83		
	universityrelated	1401	1225.50		
	Total	2452		734824.500	.102

countryMalaysia	notuniversityrelated	1051	1221.50		
	universityrelated	1401	1230.25		
	Total	2452		730970.500	.006*
countryMauritius	notuniversityrelated	1051	1226.00		
	universityrelated	1401	1226.88		
	Total	2452		735700.000	.386
countryMoldova	notuniversityrelated	1051	1226.00		
	universityrelated	1401	1226.88		
	Total	2452		735700.000	.386
countryNetherlands	notuniversityrelated	1051	1221.83		
	universityrelated	1401	1230.00		
	Total	2452		731318.000	.243
countryNewzealand	notuniversityrelated	1051	1229.67		
	universityrelated	1401	1224.13		
	Total	2452		732899.000	.182
countryNigeria	notuniversityrelated	1051	1227.83		
	universityrelated	1401	1225.50		
	Total	2452		734824.500	.102
countryNiue	notuniversityrelated	1051	1227.17		
	universityrelated	1401	1226.00		
	Total	2452		735525.000	.248
countryNorway	notuniversityrelated	1051	1227.33		
	universityrelated	1401	1225.88		
	Total	2452		735350.000	.405
countryOman	notuniversityrelated	1051	1227.17		
	universityrelated	1401	1226.00		
	Total	2452		735525.000	.248
countryPakistan	notuniversityrelated	1051	1224.00		
	universityrelated	1401	1228.38		
	Total	2452		733598.000	.053
countryPeru	notuniversityrelated	1051	1227.33		
	universityrelated	1401	1225.88		
	Total	2452		735350.000	.405
countryPhilippines	notuniversityrelated	1051	1232.83		
	universityrelated	1401	1221.75		

	Total	2452		729571.000	.002*
countryPoland	notuniversityrelated	1051	1226.00		
	universityrelated	1401	1226.88		
	Total	2452		735700.000	.386
countryPortugal	notuniversityrelated	1051	1225.50		
	universityrelated	1401	1227.25		
	Total	2452		735174.500	.221
countryQatar	notuniversityrelated	1051	1225.50		
	universityrelated	1401	1227.25		
	Total	2452		735174.500	.221
countryRomania	notuniversityrelated	1051	1227.83		
	universityrelated	1401	1225.50		
	Total	2452		734824.500	.102
countryRusia	notuniversityrelated	1051	1227.17		
	universityrelated	1401	1226.00		
	Total	2452		735525.000	.248
countrySamoa	notuniversityrelated	1051	1227.17		
	universityrelated	1401	1226.00		
	Total	2452		735525.000	.248
countrySerbia	notuniversityrelated	1051	1226.00		
	universityrelated	1401	1226.88		
	Total	2452		735700.000	.386
countrySingapore	notuniversityrelated	1051	1225.83		
	universityrelated	1401	1227.00		
	Total	2452		735523.500	.795
countrySlovenia	notuniversityrelated	1051	1227.83		
	universityrelated	1401	1225.50		
	Total	2452		734824.500	.102
countrySouthafrica	notuniversityrelated	1051	1230.00		
	universityrelated	1401	1223.88		
	Total	2452		732548.500	.104
countrySouthkorea	notuniversityrelated	1051	1227.67		
	universityrelated	1401	1225.63		
	Total	2452		735000.000	.445
countrySpain	notuniversityrelated	1051	1222.67		

	universityrelated	1401	1229.38		
	Total	2452		732196.000	.106
countrySrilanka	notuniversityrelated	1051	1227.67		
	universityrelated	1401	1225.63		
	Total	2452		735000.000	.445
countrySudan	notuniversityrelated	1051	1226.00		
	universityrelated	1401	1226.88		
	Total	2452		735700.000	.386
countrySweden	notuniversityrelated	1051	1223.83		
	universityrelated	1401	1228.50		
	Total	2452		733422.000	.261
countrySwitzerland	notuniversityrelated	1051	1225.50		
	universityrelated	1401	1227.25		
	Total	2452		735174.000	.563
countrySyria	notuniversityrelated	1051	1227.17		
	universityrelated	1401	1226.00		
	Total	2452		735525.000	.248
countryTaiwan	notuniversityrelated	1051	1227.17		
	universityrelated	1401	1226.00		
	Total	2452		735525.000	.248
countryTanzania	notuniversityrelated	1051	1227.17		
	universityrelated	1401	1226.00		
	Total	2452		735525.000	.248
countryThailand	notuniversityrelated	1051	1228.67		
	universityrelated	1401	1224.88		
	Total	2452		733949.500	.278
countryTokelau	notuniversityrelated	1051	1227.17		
	universityrelated	1401	1226.00		
	Total	2452		735525.000	.248
countryTrinidadandtobago	notuniversityrelated	1051	1227.17		
	universityrelated	1401	1226.00		
	Total	2452		735525.000	.248
countryTurkey	notuniversityrelated	1051	1226.17		
	universityrelated	1401	1226.75		
	Total	2452		735875.000	.739

countryUganda	notuniversityrelated	1051	1226.17		
	universityrelated	1401	1226.75		
	Total	2452		735875.000	.739
countryUk	notuniversityrelated	1051	1185.32		
	universityrelated	1401	1257.39		
	Total	2452		692948.000	.000*
countryUndisclosed	notuniversityrelated	1051	1394.60		
	universityrelated	1401	1100.39		
	Total	2452		559551.500	.000*
countryUnitedarabemirates	notuniversityrelated	1051	1228.33		
	universityrelated	1401	1225.13		
	Total	2452		734299.500	.261
countryUs	notuniversityrelated	1051	1117.46		
	universityrelated	1401	1308.30		
	Total	2452		621620.500	.000*
countryVietnam	notuniversityrelated	1051	1228.00		
	universityrelated	1401	1225.38		
	Total	2452		734649.500	.194

Annex 8. SDEN Top Indegree Videos

Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	Indegree
Douglas*******	us	architecture	university	business	1	case	112
Tom Dix*******	us	industrialdesign	media	designers	0	Inhabit**	79
Janine *******	us	general	media	research	0	TED	65
Life Cy******	undisclosed	general	business	designers	0	Autodes*	64
Shell E*******	netherlands	industrialdesign	business	students	1	Shell	64
Sustain*******	undisclosed	general	designers	designers	1	Tom Gre******	60
Sustain*******	us	architecture	university	designers	1	UChanne*	58
Team EP*******	netherlands	industrialdesign	students	students	1	WiredSh*******	55
Fuel Ef*******	us	industrialdesign	media	students	1	Enginee*******	52
Nanyang*******	china	industrialdesign	undisclosed	students	1	Nanyang*******	51
Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	Indegree
Douglas*******	us	architecture	university	business	1	case	112

Shell E*******	netherlands	industrialdesign	business	students	1	Shell	64
Sustain*******	undisclosed	general	designers	designers	1	Tom Gre******	60
Sustain*******	us	architecture	university	designers	1	UChanne*	58
Team EP*******	netherlands	industrialdesign	students	students	1	WiredSh*******	55
Fuel Ef*******	us	industrialdesign	media	students	1	Enginee*******	52
Nanyang*******	china	industrialdesign	undisclosed	students	1	Nanyang*******	51
Sustain*******	us	architecture	university	professors	1	Academy*******	49
Episode*******	us	industrialdesign	business	students	1	Shell #******	48
Shell E*******	indonesia	industrialdesign	university	students	1	politek*******	47

Annex 9. SDEN Top Outdegree Videos

Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	Outdegree
Life Cy*******	undisclosed	general	business	designers	0	Autodes*	23
Sustain*******	undisclosed	general	designers	designers	1	Tom Gre*******	23
Episode*******	us	industrialdesign	business	students	1	Shell #******	21
Stevens*******	us	industrialdesign	university	students	1	Stevens*******	20
Episode*******	us	industrialdesign	business	students	1	Shell #*******	20
Shell E*******	southafrica	industrialdesign	students	students	1	Ryan Co*****	19
NTUA SH*******	greece	industrialdesign	students	students	1	driving*******	19
Sustain*******	us	architecture	university	designers	1	UChanne*	18
Algorit*******	us	architecture	university	professors	1	UTSA - *******	18
Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	Outdegree
Sustain*******	undisclosed	general	designers	designers	1	Tom Gre*******	23
Episode*******	us	industrialdesign	business	students	1	Shell #******	21
Stevens*******	us	industrialdesign	university	students	1	Stevens*******	20
Episode*******	us	industrialdesign	business	students	1	Shell #******	20
Shell E*******	southafrica	industrialdesign	students	students	1	Ryan Co*****	19
NTUA SH*******	greece	industrialdesign	students	students	1	driving*******	19
Sustain*******	us	architecture	university	designers	1	UChanne*	18
Algorit*******	us	architecture	university	professors	1	UTSA - *******	18

Annex 10. SDEN Top Betweenness Videos

Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	Betweenness
Sustain*******	us	architecture	university	designers	1	UChanne*	161025.9
Douglas*******	us	architecture	university	business	1	case	154991.4
Sustain*******	us	architecture	university	professors	1	Academy*******	150137.3
Sustain*******	undisclosed	general	designers	designers	1	Tom Gre*******	134271.6
NTU stu*******	china	industrialdesign	students	students	1	NTU CoE	115229
The Fiv*******	uk	general	education	research	0	outlearn*******	112648.5
Life Cy******	undisclosed	general	business	designers	0	Autodes*	106733.7
Living *******	india	architecture	media	edupeoplemix	1	NDTV Go*******	88090.62
Story o*******	us	architecture	education	others	0	Nationa*******	86740.56
Post-Su*******	us	architecture	education	designers	0	The Asp********	84887.01
Video	Country	Design Area	Uploader	Speaker	Univ. related	Channel	Betweenness
Sustain*******	us	architecture	university	designers	1	UChannel	161025.9
Douglas*******	us	architecture	university	business	1	case	154991.4
Sustain*******	us	architecture	university	professors	1	Academy*******	150137.3
Sustain*******	undisclosed	general	designers	designers	1	Tom Gre*******	134271.6
NTU stu*******	undisclosed	industrialdesign	students	students	1	NTU CoE	115229
Living *******	india	architecture	media	edupeoplemix	1	NDTV Go*******	88090.62
Eco-vil*******	undisclosed	architecture	undisclosed	designers	1	molnard**	67645.63
2013 QU*******	australia	architecture	university	professors	1	TheQUTu**	63013.7
21. Cer*******	us	architecture	university	professors	1	YaleCou****	50960.29
Team EP******	netherlands	industrialdesign	students	students	1	WiredSh*******	48672.83

Annex 11. SDEN Top Closeness Videos

Video	Country	Design area	Uploader	Speaker	Univ. related	Channel	Closeness
UNSW SP*******	australia	mixed	university	professors	1	UNSWSPR**	13.01823
UNSW SP*******	australia	mixed	university	professors	1	UNSWSPR**	13.01823
UNSW SP*******	australia	mixed	university	professors	1	UNSWSPR**	13.01823
UNSW SP*******	australia	mixed	university	research	1	UNSWSPR**	13.0042
UNSW SP*******	australia	mixed	university	research	1	UNSWSPR**	13.0028
UNSW SP*******	australia	mixed	university	professors	1	UNSWSPR**	12.02384
UNSW SP*******	australia	mixed	university	professors	1	UNSWSPR**	12.02104

Cambrid********	uk	mixed	university	students	1	CUER Ca*******	11.34512
2014 Ye*******	us	architecture	education	designers	1	Yesterm*****	11.11615
Yesterm*******	us	architecture	education	business	1	Yesterm*****	11.11615
IBS 201*******	undisclosed	architecture	business	people	0	owensco*****	11.11615

Annex 12. SDES Most Viewed Videos

Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	# of views
Como ha********	mexico	industrialdesign	designers	designers	0	Florite**	1,015,470
Constru******	undisclosed	architecture	undisclosed	designers	0	Tierraf*******	793,373
Muebles*******	chile	industrialdesign	media	business	0	Cnnchil*	492,663
AMUEBLA********	mexico	industrialdesign	people	none	0	Hadaluz********	313,555
ARQUITE*******	argentina	architecture	media	people	1	tgmdigi***	284,718
Proceso******	colombia	architecture	business	business	0	Groncol*******	230,603
Como In********	mexico	architecture	business	business	0	Solarng****	228,012
Instala******	mexico	architecture	business	people	0	Cosecha*******	194,681
6 econt*******	undisclosed	architecture	students	none	1	ibertran***	194,265
muro ve*******	undisclosed	industrialdesign	undisclosed	designers	0	Sicalip********	164,217
Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	# of views
ARQUITE*******	argentina	architecture	media	people	1	tgmdigi***	284,718
6 econt*******	undisclosed	architecture	students	none	1	ibertran***	194,265
Tecnolo*******	spain	architecture	business	designers	1	Terapia*******	125,767
El Barr*******	undisclosed	architecture	designers	designers	1	liviako******	123,232
6 eCONT*******	undisclosed	architecture	students	students	1	Jbertra*******	68,262
Tendenc*******	argentina	mixed	designers	others_peoplemix	1	juliasa*******	64,295
Techos *******	undisclosed	architecture	business	students	1	horatos******	63,504
Diseño ******	colombia	mixed	university	others_peoplemix	1	UMB Buca******	54,779
El Barr*******	colombia	architecture	designers	designers	1	Economí*******	53,757
El Barr*******	spain	architecture	designers	designers	1	Jose Lu******	41,162

Annex 13. SDES Most Liked Videos

Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	# of likes
Como ha********	mexico	industrialdesign	designers	designers	0	Florite**	3,962
Constru******	undisclosed	architecture	undisclosed	designers	0	Tierraf*******	2,086
AMUEBLA********	mexico	industrialdesign	people	none	0	Hadaluz********	1,316
Muebles*******	chile	industrialdesign	media	business	0	Cnnchil*	741
El Barr*******	undisclosed	architecture	people	designers	1	liviako******	741
Video C*******	mexico	mixed	education	designers	0	Energia******	683
Proceso******	colombia	architecture	business	business	0	Groncol*******	633
Como In********	mexico	architecture	business	business	0	Solarng****	584
ARQUITE*******	argentina	architecture	media	people	1	tgmdigi***	567
El Barr*******	colombia	architecture	education	designers	1	Economí*******	489
Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	# of likes
Economí*******	undisclosed	architecture	people	designers	1	liviako******	741
ARQUITE*******	argentina	architecture	media	people	1	tgmdigi***	567
El Barr*******	colombia	architecture	education	designers	1	Economí*******	489
Tecnolo*******	spain	architecture	business	designers	1	Terapia*******	272
Aulas B******	panama	architecture	events	edupeoplemix	1	Premio ******	239
Animorf******	colombia	mixed	professors	people	1	Maurici*******	222
6 econt*******	undisclosed	architecture	students	none	1	Jbertra****	196
Techos *******	undisclosed	architecture	business	students	1	horatos******	190
El Barr*******	spain	architecture	designers	designers	1	Jose Lu******	186
LA ARQU*******	spain	architecture	university	professors	1	UPM	167

Annex 14. SDES Most Disliked Videos

Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	# of dislikes
Como ha********	mexico	industrialdesign	designers	designers	0	Florite**	185
Constru******	undisclosed	architecture	undisclosed	designers	0	Tierraf*******	97
Video C*******	mexico	mixed	education	designers	0	Energia******	86
Muebles*******	chile	industrialdesign	media	business	0	Cnnchil*	80
AMUEBLA********	mexico	industrialdesign	people	none	0	Hadaluz********	68
muro ve*******	undisclosed	industrialdesign	undisclosed	designers	0	Sicalip*******	35

ARQUITE*******	argentina	architecture	media	people	1	tgmdigi***	30
Anillo *******	undisclosed	industrialdesign	media	others_peoplemix	0	En Casa*******	21
Como In********	mexico	architecture	business	business	0	Solarng****	20
Butaco *******	colombia	industrialdesign	business	people	0	Estudio******	20

Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	# of dislikes
ARQUITE*******	argentina	architecture	media	people	1	tgmdigi***	30
6 eCONT*******	undisclosed	architecture	students	none	1	Jbertra*******	20
El Barr*******	undisclosed	architecture	people	designers	1	liviako******	15
Tecnolo*******	spain	architecture	business	designers	1	Terapia*******	13
Energía*******	costarica	mixed	university	research	1	Espectr*******	8
casa or*******	mexico	general	professors	none	1	Jesús S*******	7
El Barr*******	colombia	architecture	education	designers	1	Economí*******	6
Techos *******	undisclosed	architecture	business	students	1	horatos******	6
6 econt*******	undisclosed	architecture	students	students	1	Jbertra****	6
Documen*******	argentina	general	students	edupeoplemix	1	Nicolas****	6
Renovac*******	spain	architecture	media	professors	1	TEDx Ta***	6

Annex 15. SDES Most Commented Videos

Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	# of comments
Como ha********	mexico	industrialdesign	designers	designers	0	Florite**	494
Constru******	undisclosed	architecture	undisclosed	designers	0	Tierraf*******	100
Como In********	mexico	architecture	business	business	0	Solarng****	76
Techos *******	undisclosed	architecture	business	students	1	horatos******	60
ARQUITE*******	argentina	architecture	media	people	1	tgmdigi***	53
El Barr*******	undisclosed	architecture	people	designers	1	liviako******	49
Instala******	mexico	architecture	business	people	0	Cosecha******	43
Proceso******	colombia	architecture	business	business	0	Groncol*******	40
ARQUITE*******	colombia	architecture	designers	business	0	Lucia G******	39
muro ve*******	undisclosed	industrialdesign	undisclosed	designers	0	Sicalip*******	39

Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	# of comments
Techos *******	undisclosed	architecture	business	students	1	horatos******	60
ARQUITE*******	argentina	architecture	media	people	1	tgmdigi***	53

El Barr*******	undisclosed	architecture	people	designers	1	liviako******	49
6 econt*******	undisclosed	architecture	students	none	1	Jbertra****	17
UTEC nu*******	peru	architecture	university	people	1	Univers*******	17
El Barr*******	colombia	architecture	education	designers	1	Economí*******	16
LA ARQU*******	spain	architecture	university	professors	1	UPM	16
casa or*******	mexico	general	professors	none	1	Jesús S*******	15
Animorf******	colombia	mixed	professors	people	1	Maurici*******	14
El Barr*******	spain	architecture	designers	designers	1	Jose Lu******	14
Energía*******	costarica	mixed	university	research	1	Espectr*******	14

Annex 16. SDES Spearman Correlation on YouTube Metrics

		viewcount	likecount	dislikecount	commentcount
viewcount	Correlation Coefficient	1.000	.762**	.496**	.480**
	Sig. (2-tailed)		.000	.000	.000
	N	1076	1063	1063	1075
likecount	Correlation Coefficient	.762**	1.000	.474**	.536**
	Sig. (2-tailed)	.000		.000	.000
	N	1063	1063	1063	1062
dislikecount	Correlation Coefficient	.496**	.474**	1.000	.445**
	Sig. (2-tailed)	.000	.000		.000
	N	1063	1063	1063	1062
commentcount	Correlation Coefficient	.480**	.536**	.445**	1.000
	Sig. (2-tailed)	.000	.000	.000	
	N	1075	1062	1062	1075

**. Correlation is significant at the 0.01 level (2-tailed).

Annex 17. SDES Mann-Whitney U Test

Variable		N	Mean Rank	Mann-Whitney U	Asymp. Sig. (2-tailed)
viewcount	notuniversityrelated	464	583.26		
	universityrelated	612	504.56		
	Total	1076		121214.000	.000*
likecount	notuniversityrelated	458	563.26		
	universityrelated	605	508.34		
	Total	1063		124229.000	.003*
dislikecount	notuniversityrelated	458	543.74		
	universityrelated	605	523.11		
	Total	1063		133166.000	.082
commentcount	notuniversityrelated	463	555.84		
	universityrelated	612	524.50		
	Total	1075		133418.000	.024*
designareaArchitecture	notuniversityrelated	464	542.84		
	universityrelated	612	535.21		
	Total	1076		139970.000	.645
designareaGeneral	notuniversityrelated	464	543.77		
	universityrelated	612	534.50		
	Total	1076		139538.000	.369
designareaGraphicdesign	notuniversityrelated	464	541.15		
	universityrelated	612	536.49		
	Total	1076		140756.000	.524
designareaIndustrialdesign	notuniversityrelated	464	536.10		
	universityrelated	612	540.32		
	Total	1076		140870.000	.737
designareaMixed	notuniversityrelated	464	528.64		
	universityrelated	612	545.97		
	Total	1076		137410.000	.169
uploaderareaBusiness	notuniversityrelated	464	588.45		
	universityrelated	612	500.63		
	Total	1076		118808.000	.000*
uploaderareaDesigners	notuniversityrelated	464	546.58		
	universityrelated	612	532.37		

	Total	1076		138234.000	.072
uploaderareaEducation	notuniversityrelated	464	567.65		
	universityrelated	612	516.40		
	Total	1076		128458.000	.000*
uploaderareaEvents	notuniversityrelated	464	537.14		
	universityrelated	612	539.53		
	Total	1076		141352.000	.491
uploaderareaGovernment	notuniversityrelated	464	541.87		
	universityrelated	612	535.94		
	Total	1076		140420.000	.313
uploaderareaMedia	notuniversityrelated	464	572.33		
	universityrelated	612	512.85		
	Total	1076		126286.000	.000*
uploaderareaPeople	notuniversityrelated	464	550.55		
	universityrelated	612	529.37		
	Total	1076		136394.000	.044*
uploaderareaProfessors	notuniversityrelated	464	530.00		
	universityrelated	612	544.94		
	Total	1076		138040.000	.000*
uploaderareaResearch	notuniversityrelated	464	541.44		
	universityrelated	612	536.27		
	Total	1076		140622.000	.184
uploaderareaStudents	notuniversityrelated	464	502.96		
	universityrelated	612	565.45		
	Total	1076		125492.000	.000*
uploaderareaUndisclosed	notuniversityrelated	464	556.04		
	universityrelated	612	525.20		
	Total	1076		133846.000	.000*
uploaderareaUniversity	notuniversityrelated	464	427.00		
	universityrelated	612	623.04		
	Total	1076		90248.000	.000*
speakerareaBusiness	notuniversityrelated	464	553.28		
	universityrelated	612	527.29		
	Total	1076		135124.000	.000*
speakerareaDesigners	notuniversityrelated	464	582.64		

	universityrelated	612	505.04		
	Total	1076		121504.000	.000*
speakerareaEducation	notuniversityrelated	464	550.97		
	universityrelated	612	529.05		
	Total	1076		136200.000	.000*
speakerareaEdupeoplemix	notuniversityrelated	464	489.55		
	universityrelated	612	575.61		
	Total	1076		119272.000	.000*
speakerareaGovernment	notuniversityrelated	464	540.12		
	universityrelated	612	537.27		
	Total	1076		141234.000	.432
speakerareaMedia	notuniversityrelated	464	544.59		
	universityrelated	612	533.88		
	Total	1076		139156.000	.001*
speakerareaNone	notuniversityrelated	464	566.55		
	universityrelated	612	517.24		
	Total	1076		128970.000	.000*
speakerareaOthersmix	notuniversityrelated	464	552.94		
	universityrelated	612	527.55		
	Total	1076		135282.000	.000*
speakerareaPeople	notuniversityrelated	464	570.78		
	universityrelated	612	514.03		
	Total	1076		127008.000	.000*
speakerareaProfessors	notuniversityrelated	464	480.00		
	universityrelated	612	582.85		
	Total	1076		114840.000	.000*
speakerareaResearch	notuniversityrelated	464	542.17		
	universityrelated	612	535.72		
	Total	1076		140282.000	.336
speakerareaStudents	notuniversityrelated	464	488.41		
	universityrelated	612	576.47		
	Total	1076		118744.000	.000*
countryArgentina	notuniversityrelated	464	554.61		
	universityrelated	612	526.28		
	Total	1076		134508.000	.002*

countryBolivia	notuniversityrelated	464	538.66		
	universityrelated	612	538.38		
	Total	1076		141910.000	.844
countryBrazil	notuniversityrelated	464	538.00		
	universityrelated	612	538.88		
	Total	1076		141752.000	.384
countryChile	notuniversityrelated	464	527.59		
	universityrelated	612	546.77		
	Total	1076		136924.000	.004*
countryColombia	notuniversityrelated	464	505.31		
	universityrelated	612	563.66		
	Total	1076		126586.000	.000*
countryCostarica	notuniversityrelated	464	536.48		
	universityrelated	612	540.03		
	Total	1076		141046.000	.286
countryDominicanrepublic	notuniversityrelated	464	536.00		
	universityrelated	612	540.40		
	Total	1076		140824.000	.051
countryEcuador	notuniversityrelated	464	536.48		
	universityrelated	612	540.03		
	Total	1076		141046.000	.286
countryElsalvador	notuniversityrelated	464	537.50		
	universityrelated	612	539.26		
	Total	1076		141520.000	.218
countryFrance	notuniversityrelated	464	539.82		
	universityrelated	612	537.50		
	Total	1076		141372.000	.104
countryGermany	notuniversityrelated	464	539.32		
	universityrelated	612	537.88		
	Total	1076		141604.000	.410
countryGuatemala	notuniversityrelated	464	536.16		
	universityrelated	612	540.27		
	Total	1076		140898.000	.122
countryHonduras	notuniversityrelated	464	537.50		
	universityrelated	612	539.26		

	Total	1076		141520.000	.218
countryItaly	notuniversityrelated	464	539.16		
	universityrelated	612	538.00		
	Total	1076		141678.000	.251
countryMexico	notuniversityrelated	464	520.26		
	universityrelated	612	552.33		
	Total	1076		133522.000	.002*
countryNicaragua	notuniversityrelated	464	539.16		
	universityrelated	612	538.00		
	Total	1076		141678.000	.251
countryPanama	notuniversityrelated	464	535.16		
	universityrelated	612	541.03		
	Total	1076		140434.000	.052
countryParaguay	notuniversityrelated	464	538.32		
	universityrelated	612	538.64		
	Total	1076		141900.000	.888
countryPeru	notuniversityrelated	464	542.71		
	universityrelated	612	535.31		
	Total	1076		140030.000	.182
countrySpain	notuniversityrelated	464	523.35		
	universityrelated	612	549.98		
	Total	1076		134956.000	.053
countryUndisclosed	notuniversityrelated	464	603.71		
	universityrelated	612	489.06		
	Total	1076		111728.000	.000*
countryUruguay	notuniversityrelated	464	540.48		
	universityrelated	612	537.00		
	Total	1076		141066.000	.046*
countryUs	notuniversityrelated	464	536.48		
	universityrelated	612	540.03		
	Total	1076		141046.000	.286
countryVenezuela	notuniversityrelated	464	541.78		
	universityrelated	612	536.02		
	Total	1076		140464.000	.098

Annex 18. SDES Top Indegree Videos

Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	Indegree
ARQUITE*******	argentina	architecture	media	people	1	tgmdigi***	38
Curso d*******	spain	architecture	education	designers	0	ruralab**	34
Univers*******	mexico	general	university	edupeoplemix	1	Univers*******	25
LA ARQU*******	spain	architecture	university	professors	1	UPM	24
Constru********	spain	architecture	business	people	0	ACCIONA	18
Ecodise**	colombia	industrialdesign	students	none	1	Lizeth*******	18
Constru*******	undisclosed	architecture	business	none	0	Grupocon*****	17
Eco-dis*******	france	mixed	business	people	0	Expansc*****	17
Eco dis********	undisclosed	architecture	people	edupeoplemix	1	Fer Tid*******	17
Eco-efi********	colombia	industrialdesign	students	students	1	Aparias*******	17
Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	Indegree
ARQUITE*******	argentina	architecture	media	people	1	tgmdigi***	38
Univers*******	mexico	general	university	edupeoplemix	1	Univers*******	25
LA ARQU*******	spain	architecture	university	professors	1	UPM	24
Ecodis*******	colombia	industrialdesign	students	none	1	Lizeth*******	18
Eco dis********	undisclosed	architecture	people	edupeoplemix	1	Fer Tid*******	17
Eco-efi********	colombia	industrialdesign	students	students	1	Aparias*******	17
EDIFICI*******	spain	architecture	university	people	1	Iescarm******	16
Video C*******	colombia	industrialdesign	students	people	1	Andrés *******	16

Annex 19. SDES Top Outdegree Videos

Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	Outdegree
Univers*******	mexico	general	university	edupeoplemix	1	Univers*******	21
Ecodise**	colombia	industrialdesign	students	none	1	Lizeth*******	16
eco-DIS******	undisclosed	industrialdesign	undisclosed	none	0	LAS3CAS*******	15
Eco dis********	undisclosed	architecture	people	edupeoplemix	1	Fer Tid*******	14
Constru********	colombia	architecture	education	media	0	SENATV	14
Constru********	spain	architecture	business	people	0	ACCIONA	13
Ecodise**	undisclosed	mixed	people	people	0	Sebasti*******	13
Univers*******	mexico	industrialdesign	university	edupeoplemix	1	Univers*******	13

Constru*******	spain	architecture	university	none	1	EOI Esc*******	13
Univers*******	mexico	mixed	university	edupeoplemix	1	Univers*******	13
Ecodise**	undisclosed	general	people	people	0	Sol de *******	13
Hande E*******	colombia	general	designers	none	0	Elsa Fi*******	13
Ecodise**	undisclosed	general	people	people	0	Fedrico******	13

Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	Outdegree
Univers*******	mexico	general	university	edupeoplemix	1	Univers*******	21
Ecodise**	colombia	industrialdesign	students	none	1	Lizeth*******	16
Eco dis********	undisclosed	architecture	people	edupeoplemix	1	Fer Tid*******	14
Univers*******	mexico	industrialdesign	university	edupeoplemix	1	Univers*******	13
Constru********	spain	architecture	university	none	1	EOI Esc*******	13
Univers*******	mexico	mixed	university	edupeoplemix	1	Univers*******	13
El ecod*******	spain	architecture	education	business	1	Asociac*******	12
DISEño *******	colombia	mixed	university	professors	1	Univers******	12
Catalin*******	colombia	mixed	university	students	1	Pascual*******	12

Annex 20. SDES Top Betweenness Videos

Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	Betweenness
DISEño ******	colombia	mixed	university	professors	1	Univers******	21878.63
Propues******	argentina	mixed	media	designers	0	Modabit******	13025.48
Curso d******	spain	architecture	education	designers	0	ruralab******	12017.29
Damián******	argentina	industrialdesign	university	students	1	Emprende****	12016.89
Economí*****	undisclosed	mixed	media	edupeoplemix	1	Mindali******	11751.89
EcoDise******	chile	general	people	professors	1	Cristian******	11492.78
Ecodise******	undisclosed	general	people	people	0	LAURA M****	11419.67
Vivo en******	argentina	architecture	media	others_peoplemix	0	TV Públi******	9408.644
Diseño******	undisclosed	architecture	undisclosed	edupeoplemix	0	250tnie*****	9356.002
Lifegis*******	spain	mixed	business	people	0	Lifegis******	8258.973

Video	Country	Design Area	Uploader Area	Speaker Area	Univ. related	Channel	Betweenness
DISEño*******	colombia	mixed	university	professors	1	Univers******	21878.63
Damián******	argentina	industrialdesign	university	students	1	Emprend*****	12016.89
Economí*****	undisclosed	mixed	media	edupeoplemix	1	Mindali******	11751.89
EcoDise*****	chile	general	people	professors	1	Cristian******	11492.78
IED Bar******	spain	industrialdesign	university	edupeoplemix	1	IED Bar******	8095.281
Entrevi*******	spain	industrialdesign	university	students	1	IED Bar******	7848.682
Jorge R******	colombia	architecture	university	designers	1	ExkemaTV	6789.124
EDIFICI******	spain	architecture	university	people	1	Iescarm******	5990.28
Univers******	mexico	mixed	university	edupeoplemix	1	Univers******	5890.405
ParaBus******	undisclosed	industrialdesign	business	none	1	ArzateD*****	4937.099

Annex 21. SDES Top Closeness Videos

Video	Country	Design area	Uploader	Speaker	Univ. related	Channel	Closeness
ECOALDE*******	undisclosed	architecture	business	professors	1	Diseño*******	12.50877
eco des*******	undisclosed	general	people	people	0	Claudet******	12.10448
Eco-des*******	france	mixed	business	people	0	Expansc*******	12.10448
Ponenci*******	spain	general	business	business	0	Junkers******	12.0597
El bar******	colombia	architecture	education	designers	1	Economí*******	11.64889
El bar******	undisclosed	architecture	undisclosed	designers	1	Desorde******	11.60177
Curso C******	argentina	architecture	education	education	0	Asociac******	11.51754
Impresi******	argentina	architecture	education	students	0	Asociac******	11.51316
Innovac******	spain	industrialdesign	business	designers	0	Ana Yag******	11.28996
Diseño*******	colombia	mixed	university	others_peoplemix	1	UMB Buca*******	11.27612

Video	Country	Design area	Uploader	Speaker	Univ. related	Channel	Closeness
ECOALDE*******	undisclosed	architecture	business	professors	1	Diseño*******	12.50877
El Barr*******	colombia	architecture	education	designers	1	Economí*******	11.64889
El bar******	undisclosed	architecture	undisclosed	designers	1	Desorde******	11.60177
Diseño*******	colombia	mixed	university	others_peoplemix	1	UMB Buca*******	11.27612

Asignatu*******	colombia	mixed	university	students	1	Pascualb*******	11.23134
Asignat*******	colombia	mixed	university	students	1	Pascualb*******	11.22761
Asignat*******	colombia	mixed	university	students	1	Pascualb*******	11.22761
Daniela*******	colombia	mixed	university	students	1	Pascualb*******	11.21642
CURSO E*******	undisclosed	architecture	people	professors	1	Bernard******	11.11194
Taller*******	spain	general	university	designers	1	EOI Esc*******	11.06343

Annex 22. Intercoder Agreement

English Intercoder Agreement			Spanish Intercoder Agreement		
Coder Pair	**Agreement**	**Macro Agreement**	**Coder Pair**	**Agreement**	**Macro Agreement**
A-B	62.5	72.5	**A-G**	75	82.5
A-C	63.75	75	**A-H**	75	80
A-D	56.25	70	**A-I**	57.5	80
A-E	57.5	57.5	**A-J**	57.5	77.5
A-F	70	75	**A-K**	71.25	77.5

Annex 23. Polarity and Typology Sentiment Scores Correlations in SDEN

Spearman Correlations									
	positive	negative	anger	anticipation	disgust	fear	joy	sadness	trust
positive	1.000	-.085**	.119**	.294**	.117**	.130**	.438**	.149**	.318**
negative	-.085**	1.000	-.547**	-.316**	-.541**	-.550**	-.260**	-.538**	-.363**
anger	.119**	-.547**	1.000	.386**	.616**	.625**	.329**	.608**	.399**
anticipation	.294**	-.316**	.386**	1.000	.297**	.394**	.658**	.350**	.644**
disgust	.117**	-.541**	.616**	.297**	1.000	.522**	.270**	.560**	.321**
fear	.130**	-.550**	.625**	.394**	.522**	1.000	.317**	.686**	.395**
joy	.438**	-.260**	.329**	.658**	.270**	.317**	1.000	.322**	.708**
sadness	.149**	-.538**	.608**	.350**	.560**	.686**	.322**	1.000	.371**
trust	.318**	-.363**	.399**	.644**	.321**	.395**	.708**	.371**	1.000
** N=13976, P<0.005									

Annex 24. Polarity and Typology Sentiment Scores Correlations in SDES

Spearman Correlations									
	positive	negative	anger	anticipation	disgust	fear	joy	sadness	trust
positive	1.000	.071**	.096**	.239**	.114**	.143**	.376**	.355**	.350**
negative	.071**	1.000	-.290**	-.108**	-.287**	-.316**	-.065*	-.287**	-.138**
anger	.096**	-.290**	1.000	.241**	.577**	.544**	.188**	.349**	.218**
anticipation	.239**	-.108**	.241**	1.000	.186**	.352**	.583**	.263**	.557**
disgust	.114**	-.287**	.577**	.186**	1.000	.478**	.129**	.426**	.205**
fear	.143**	-.316**	.544**	.352**	.478**	1.000	.239**	.479**	.314**
joy	.376**	-.065*	.188**	.583**	.129**	.239**	1.000	.252**	.691**
sadness	.355**	-.287**	.349**	.263**	.426**	.479**	.252**	1.000	.305**
trust	.350**	-.138**	.218**	.557**	.205**	.314**	.691**	.305**	1.000
** P<0.005, *.P<0.05, N=1351									

Annex 25. Sample of Top 14 Word Clusters in SDEN A-list

1. James	2. Ignorance	3. She	4. Energy	5. People	6. Holistic	7. He
I	you	gsexc1 (!)	energy	people	we	he
gsplus2 (+)	your	me	car	like	need	his
know	think	video	power	their	our	man
say	want	great	solar	live	us	guy
gsat2 (@)	find	thank	gspercent1	everyone	earth	elonmusk
point	yourself	love	cost	living	already	him
said	research	talk	battery	country	planet	god
understand	fuck	gsgrin5	water	sound	environment	tesla
yes	learn	please	using	rich	animal	model
agree	call	lol	nuclear	poor		book

8. Design	9. American	10. Science-Technology	11. Information	12. Money	13. Jacque	14. System
city	they	world	no	make	year	system
house	because	better	idea	work	jacquefresco	never
design	them	new	self	money	U.S.	change
build	children	technology	whole	resource	old	always
place	against	thevenusproject	word	sense	culture	happen
home	kid	society	matter	control	few	become

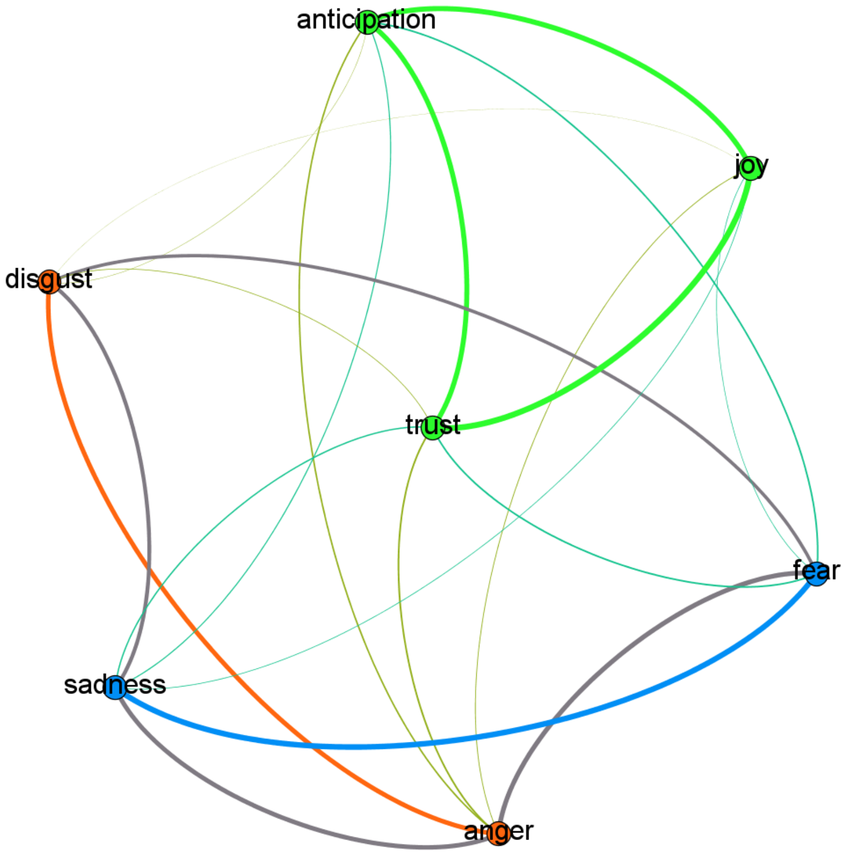
building	men	science	information	buy	war	value
project	themselves	end	opinion	product	history	probably
small	allow	sustainable	form	reality	level	able
land	American	run	argument	difference	religion	current

Annex 26. Sample of Top 14 Word Clusters in SDES A-list

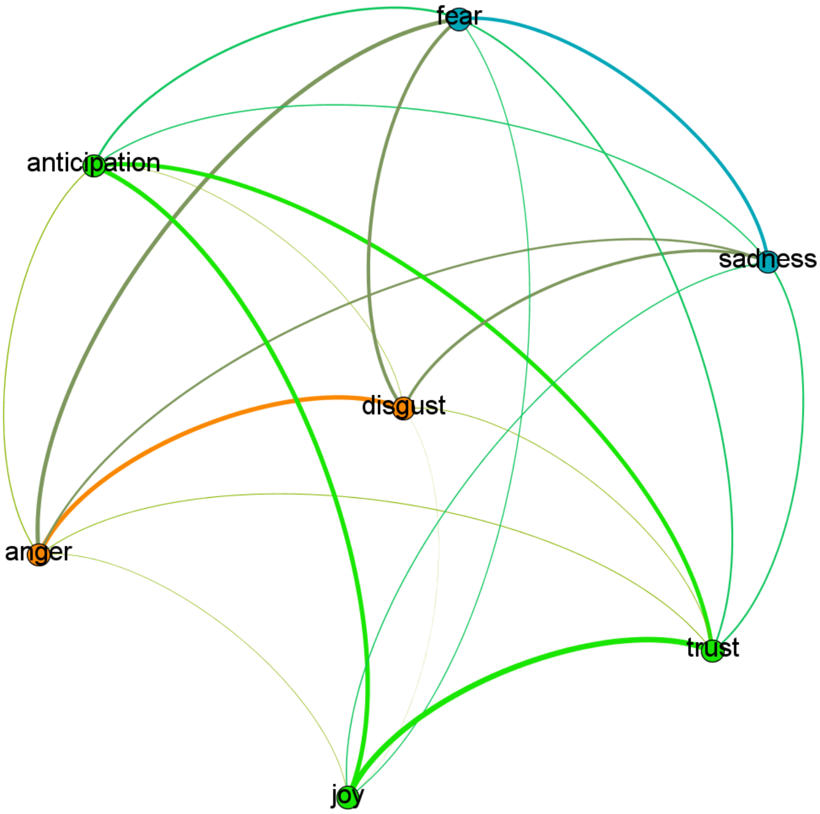
1. Jorge	2. System	3. Bullfighting	4. Economy	5. Adobe	6. House	7. Chile - US
gsexc1	no	youtube	si	mi	casa	materiales
gracias	ya	gsat2	tiempo	saber	hacer	madera
video	sistema	google	alguien	gustaría	techo	botella
excelente	porque	plus	interesa	contacto	barro	creo
idea	año	hashtag	existe	favor	construir	tecnología
trabajo	hace	gshash2	economico	quisiera	quiero	realidad
interesante	energía	contra	ecologica	adobe	verde	uso
buen	invertidores	barbarie	quiere	dar	realmente	felicito
hecho	agua	aragüenios	social	súper	necesito	U.S.
compartir	debe	pronuncian	consumo	hotmail	aprender	detalle

8. Mexico	9. Latinamericans	10. Information	11. Housing	12. Argentina	13. Earth	14. Lucia
páneles	bueno	informacion	vivienda	saludo	tierra	gsat1
yo	nuestro	facebook	mejor	construccion	problema	correo
México	persona	taller	vida	aqui	diferente	luciagarzon
solares	conocimiento	pagina	nueva	argentina	paredes	arquitecto
costo	ellos	tema	podria	natural	estructura	gmail
importante	vivir	comunidad	conseguir	instalacion	constructivo	mayor
ambiente	necesidad	sera	recursos	universidad	usted	hora
dolares	concepto	dialogandoconlatierra	barata	aca	siempre	tel
ahi	estudiante	web	sustentable	grande	cubierta	bioarquitecturatierra
vivo	familia	interesado	vender	link	cal	villa

Annex 27. SDEN Network of Sentiment Categories based on Spearman Correlations.



Annex 28. SDES Network of Sentiment Categories based on Spearman Correlations.



Annex 29. Recommendation System Main Code

Get_video (matches the variables Input by the user with variables stored in the databases)

```
<?php
        session_start();
        $lang = $_SESSION['lang'];

        $occupation = "speakerarea_".$_POST['occupation']."_num";
        $field = "designarea_".$_POST['field']."_num";
        $country = "continent_".$_POST['country']."_num";
        $interest = $_POST['interest'];
        $feel = $_POST['feel'];
        $user = $_POST['user'];

        include("config.php");
        include("httpful.phar");
```

```
$mysqli = new mysqli($host, $username, $password, $database);

//polarity_vector
$polarity_v = array(0, 0, 0, 0, 0, 0, 0);//7 elements
switch ($user) {
        case 'interested':
                $polarity_v[3] = 1;//interested user (0,0,0,1,0,0,0)
                break;
        case 'indecisive':
                $polarity_v[2] = 1;//indecisive user (0,1,0,0,0,0,0)
                break;
        case 'uninterested':
                $polarity_v[6] = 1;//uninterested user (0,0,0,0,0,0,1)
                break;
        default:
                $polarity_v[3] = 1;
}

//occupation_vector
$occupation_v = array(0, 0, 0, 0, 0, 0, 0, 0, 0);//9 elements
switch ($_POST['occupation']) {
        case 'business':
                $occupation_v[0] = 1;
                break;
        case 'designers':
                $occupation_v[1] = 1;
                break;
        case 'education':
                $occupation_v[2] = 1;
                break;
        case 'government':
                $occupation_v[3] = 1;
                break;
        case 'none':
                $occupation_v[4] = 1;
```

```
                break;
        case 'others':
                $occupation_v[5] = 1;
                break;
        case 'professors':
                $occupation_v[6] = 1;
                break;
        case 'research':
                $occupation_v[7] = 1;
                break;
        case 'students':
                $occupation_v[8] = 1;
                break;
        default:
                $occupation_v[0] = 1;
}

//expertise field_vector
$field_v = array(0, 0, 0, 0, 0, 0);//6 elements
switch ($_POST['field']) {
        case 'architecture':
                $field_v[0] = 1;
                break;
        case 'engineering':
                $field_v[1] = 1;
                break;
        case 'general':
                $field_v[2] = 1;
                break;
        case 'graphicdesign':
                $field_v[3] = 1;
                break;
        case 'industrialdesign':
                $field_v[4] = 1;
                break;
        case 'mixed':
```

```
                        $field_v[5] = 1;
                        break;
                default:
                        $field_v[0] = 1;
        }

        //country_vector
        $query_country = "SELECT DISTINCT Continent FROM continent_country WHERE
Country='".$_POST['country']."'";
        $result_country = $mysqli->query($query_country);
        $row_country = $result_country->fetch_assoc();
        $continent = $row_country['Continent'];

        $country_v = array(0, 0, 0, 0, 0, 0, 0, 0);//8 elements

        switch ($continent) {
                case 'africa':
                        $country_v[0] = 1;
                        break;
                case 'asia':
                        $country_v[1] = 1;
                        break;
                case 'europe':
                        $country_v[2] = 1;
                        break;
                case 'latinamerica':
                        $country_v[3] = 1;
                        break;
                case 'northamerica':
                        $country_v[4] = 1;
                        break;
                case 'oceania':
                        $country_v[5] = 1;
                        break;
                case 'southasia':
                        $country_v[6] = 1;
```

```
                        break;
                case 'undisclosed':
                        $country_v[7] = 1;
                        break;
                default:
                        $country_v[0] = 1;
        }
        //when click the search button
        if (isset($_POST['topic'])) {
                //topic vector
                $topic = $_POST['topic'];
                if ($lang == 'en')
                        $query_topic = "SELECT DISTINCT * FROM topics_english WHERE
keyword='".$topic."'";
                elseif ($lang == 'sp') {
                        $query_topic = "SELECT DISTINCT * FROM topics_spanish WHERE
keyword='".$topic."'";
                }

                $result_topic = $mysqli->query($query_topic);
                $row_topic = $result_topic->fetch_assoc();
                $category = $row_topic['category'];

                $topic_v = array(0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0);//14
elements

                if ($lang == 'en') {
                        switch ($category) {
                                case 'american':
                                        $topic_v[0] = 1;
                                        break;
                                case 'design':
                                        $topic_v[1] = 1;
                                        break;
                                case 'energy':
                                        $topic_v[2] = 1;
```

```
        break;
case 'he':
        $topic_v[3] = 1;
        break;
case 'holistic':
        $topic_v[4] = 1;
        break;
case 'ignorance':
        $topic_v[5] = 1;
        break;
case 'information':
        $topic_v[6] = 1;
        break;
case 'jacquefresco':
        $topic_v[7] = 1;
        break;
case 'jamesbond':
        $topic_v[8] = 1;
        break;
case 'money':
        $topic_v[9] = 1;
        break;
case 'people':
        $topic_v[10] = 1;
        break;
case 'scitech':
        $topic_v[11] = 1;
        break;
case 'she':
        $topic_v[12] = 1;
        break;
case 'system':
        $topic_v[13] = 1;
        break;
default:
        $topic_v[0] = 1;
```

```
        }
}
elseif ($lang == 'sp') {
        switch ($category) {
                case 'adobe':
                        $topic_v[0] = 1;
                        break;
                case 'bullfighting':
                        $topic_v[1] = 1;
                        break;
                case 'chileus':
                        $topic_v[2] = 1;
                        break;
                case 'earth':
                        $topic_v[3] = 1;
                        break;
                case 'economy':
                        $topic_v[4] = 1;
                        break;
                case 'energy':
                        $country_v[5] = 1;
                        break;
                case 'house':
                        $topic_v[6] = 1;
                        break;
                case 'housing':
                        $topic_v[7] = 1;
                        break;
                case 'information':
                        $topic_v[8] = 1;
                        break;
                case 'jorgebelanko':
                        $topic_v[9] = 1;
                        break;
                case 'latinamericans':
                        $topic_v[10] = 1;
```

```
                                        break;
                                case 'luciagarzon':
                                        $topic_v[11] = 1;
                                        break;
                                case 'mexico':
                                        $topic_v[12] = 1;
                                        break;
                                case 'system':
                                        $topic_v[13] = 1;
                                        break;
                                default:
                                        $topic_v[0] = 1;
                        }
                }

                if ($lang == 'en')
                        $query = "CALL SearchVideoEn($occupation_v[0],
$occupation_v[1], $occupation_v[2], $occupation_v[3], $occupation_v[4],
$occupation_v[5], $occupation_v[6], $occupation_v[7], $occupation_v[8], $field_v[0],
$field_v[1], $field_v[2], $field_v[3], $field_v[4], $field_v[5], $country_v[0],
$country_v[1], $country_v[2], $country_v[3], $country_v[4], $country_v[5],
$country_v[6], $country_v[7], $interest, $feel, $polarity_v[0], $polarity_v[1],
$polarity_v[2], $polarity_v[3], $polarity_v[4], $polarity_v[5], $polarity_v[6],
$topic_v[0], $topic_v[1], $topic_v[2], $topic_v[3], $topic_v[4], $topic_v[5],
$topic_v[6], $topic_v[7], $topic_v[8], $topic_v[9], $topic_v[10], $topic_v[11],
$topic_v[12], $topic_v[13])";
                elseif ($lang == 'sp')
                        $query = "CALL SearchVideoSp($occupation_v[0],
$occupation_v[1], $occupation_v[2], $occupation_v[3], $occupation_v[4],
$occupation_v[5], $occupation_v[6], $occupation_v[7], $occupation_v[8], $field_v[0],
$field_v[1], $field_v[2], $field_v[3], $field_v[4], $field_v[5], $country_v[0],
$country_v[1], $country_v[2], $country_v[3], $country_v[4], $country_v[5],
$country_v[6], $country_v[7], $interest, $feel, $polarity_v[0], $polarity_v[1],
$polarity_v[2], $polarity_v[3], $polarity_v[4], $polarity_v[5], $polarity_v[6],
$topic_v[0], $topic_v[1], $topic_v[2], $topic_v[3], $topic_v[4], $topic_v[5],
```

```
$topic_v[6], $topic_v[7], $topic_v[8], $topic_v[9], $topic_v[10], $topic_v[11],
$topic_v[12], $topic_v[13])";
        }
        else {
                if ($lang == 'en')
                        $query = "CALL GetVideoEn($occupation_v[0], $occupation_v[1],
$occupation_v[2], $occupation_v[3], $occupation_v[4], $occupation_v[5],
$occupation_v[6], $occupation_v[7], $occupation_v[8], $field_v[0], $field_v[1],
$field_v[2], $field_v[3], $field_v[4], $field_v[5], $country_v[0], $country_v[1],
$country_v[2], $country_v[3], $country_v[4], $country_v[5], $country_v[6],
$country_v[7], $interest, $feel, $polarity_v[0], $polarity_v[1], $polarity_v[2],
$polarity_v[3], $polarity_v[4], $polarity_v[5], $polarity_v[6])";
                elseif ($lang == 'sp')
                        $query = "CALL GetVideoSp($occupation_v[0], $occupation_v[1],
$occupation_v[2], $occupation_v[3], $occupation_v[4], $occupation_v[5],
$occupation_v[6], $occupation_v[7], $occupation_v[8], $field_v[0], $field_v[1],
$field_v[2], $field_v[3], $field_v[4], $field_v[5], $country_v[0], $country_v[1],
$country_v[2], $country_v[3], $country_v[4], $country_v[5], $country_v[6],
$country_v[7], $interest, $feel, $polarity_v[0], $polarity_v[1], $polarity_v[2],
$polarity_v[3], $polarity_v[4], $polarity_v[5], $polarity_v[6])";
        }

        $result = $mysqli->query($query);
        $video_res = array();
        $youtubeVidIds = array();

        while ($row = $result->fetch_assoc()) {
                $video_res[] = $row;
                $youtubeVidIds[] = $row['video_id'];
        }

        $response =
¥Httpful¥Request::get("https://www.googleapis.com/youtube/v3/videos?key=AIzaSyDjXEtXEC5x
HnXF80coVZcxY425YKvNMKc&part=snippet&id=".implode (",",$youtubeVidIds)."")->send();

        $response = json_decode($response);
```

```
        $data = array('video'=>$video_res, 'thumbnail'=>$response);

        header('Content-type: text/json');

        echo json_encode($data);
?>
```

Request

```
<?php
        session_start();

        if (isset($_GET['lang']))
        {
                $lang = $_GET['lang'];
                $_SESSION['lang'] = $lang;
        }
        else {
                $lang = 'en';
        }
?>
<?php
        $uri = $_SERVER['REQUEST_URI'];
        $dir = substr($uri, 0, strrpos($uri, '/') + 1);
        $prefix = "http://$_SERVER[HTTP_HOST]" . $dir;
?>

<!DOCTYPE html>
<html>
<head>
        <meta name="viewport" content="width=device-width, initial-scale=1.0">
        <title>LookEcoD 1.0</title>
        <link rel="stylesheet"
href="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.7/css/bootstrap.min.css">
        <link rel="stylesheet" href="//code.jquery.com/ui/1.12.1/themes/base/jquery-
ui.css">
```

```
        <link rel="stylesheet" type="text/css" href="css/main.css">

        <script
src="https://ajax.googleapis.com/ajax/libs/jquery/3.3.1/jquery.min.js"></script>
        <script
src="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.7/js/bootstrap.min.js"></script>
        <script src="https://code.jquery.com/ui/1.12.1/jquery-ui.js"></script>
        <script>
                var lang = "<?php echo $lang; ?>";
        </script>
        <script src="js/autocomplete.js"></script>
</head>
<body>
        <div class="container-fluid">
                <div class="container">
                        <div class="col-md-8 col-md-offset-2">
                                <form class="form-container" id="form-login"
action="home.php" method="POST">
                                        <div class="row" id="request_title">
                                                <p>LookEcoD 1.0</p>
                                        </div>
                                        <!-- topic -->
                                        <div class="row" id="topic">
                                        <?php if ($lang == 'en'):?>
                                                I am a
                                                <input type="text" id="occupation"
name="occupation" placeholder="occupation" style="width: 18%;" autofocus
required="required">
                                                of
                                                <input type="text" id="field"
name="field" placeholder="expertise field" style="width: 25%;" required>
                                                from
                                                <select id="select_country"
style="width: 23%;" name="country" required></select>
                                        <?php elseif ($lang == 'sp'):?>
                                                Soy
```

```
                                                    <input type="text" id="occupation"
name="occupation" placeholder="ocupación" style="width: 18%;" autofocus required>
                                                    en
                                                    <input type="text" id="field"
name="field" placeholder="área de conocimiento" style="width: 36%;" required>
                                                    de
                                                    <select id="select_country"
style="width: 23%;" name="country" required></select>
                                            <?php endif; ?>
                                            </div>
                                            <!-- /topic -->
                                            <!-- interest level -->
                                            <div class="row" id="level">
                                                    <div class="row" style="padding: 5px
0;">
                                                    <?php if ($lang == 'en'):?>
                                                            <center><p>My level of
interest in this topic is:</p></center>
                                                    <?php elseif ($lang == 'sp'):?>
                                                            <center><p>Mi interés en
este tema es:</p></center>
                                                    <?php endif; ?>
                                                    </div>
                                                    <div class="row"
id="interest_level">
                                                    <?php if ($lang == 'en'):?>
                                                            <div class="col-sm-6"
style="text-align: left;">Not Interested</div>
                                                            <div class="col-sm-6"
style="text-align: right;">Very Interested</div>
                                                    <?php elseif ($lang == 'sp'):?>
                                                            <div class="col-sm-6"
style="text-align: left;">Ningún Interés</div>
                                                            <div class="col-sm-6"
style="text-align: right;">Mucho Interés</div>
                                                    <?php endif; ?>
```

```
                                                </div>
                                                <div class="row" id="num">
                                                        <div class="col-sm-4"
style="text-align: left;">0</div>
                                                        <div class="col-sm-4"
style="text-align: center;">5</div>
                                                        <div class="col-sm-4"
style="text-align: right;">10</div>
                                                </div>
                                                <div class="range" id="level_range">
                                                        <input type="range"
class="slider" id="interest_slider" min="0" max="10" value="5" step="1"
oninput="sliderChange1(this.value)" onchange="sliderChange1(this.value)" />
                                                        <ul class="range-labels"
id="level_range_labels">
                                                                <li>0</li>
                                                                <li>1</li>
                                                                <li>2</li>
                                                                <li>3</li>
                                                                <li>4</li>
                                                                <li class="active
selected">5</li>
                                                                <li>6</li>
                                                                <li>7</li>
                                                                <li>8</li>
                                                                <li>9</li>
                                                                <li>10</li>
                                                        </ul>
                                                </div>
                                        </div>
                                        <!-- /interest level -->
                                        <!-- feel level -->
                                        <div class="row" id="feel">
                                                <div class="row" style="padding: 5px
0;">
                                                <?php if ($lang == 'en'):?>
```

```
                                                  <center><p>What I feel
about this topic is:</p></center>
                                          <?php elseif ($lang == 'sp'):?>
                                                  <center><p>¿Cómo me siento
respecto a este tema?</p></center>
                                          <?php endif; ?>
                                          </div>
                                          <div class="row" id="feel_level">
                                          <?php if ($lang == 'en'):?>
                                                  <div class="col-sm-4"
style="text-align: left;">Bad</div>
                                                  <div class="col-sm-
4">Neutral</div>
                                                  <div class="col-sm-4"
style="text-align: right;">Good</div>
                                          <?php elseif ($lang == 'sp'):?>
                                                  <div class="col-sm-4"
style="text-align: left;">Mal</div>
                                                  <div class="col-sm-
4">Neutral</div>
                                                  <div class="col-sm-4"
style="text-align: right;">Bien</div>
                                          <?php endif; ?>
                                          </div>
                                          <div class="row" id="num">
                                                  <div class="col-sm-4"
style="text-align: left;">-5</div>
                                                  <div class="col-sm-4"
style="text-align: center;">0</div>
                                                  <div class="col-sm-4"
style="text-align: right;">5</div>
                                          </div>
                                          <div class="range" id="feel_range">
                                                  <input type="range"
class="slider" id="feel_slider" min="-5" max="5" value="0" step="1"
oninput="sliderChange2(this.value)" onchange="sliderChange2(this.value)" />
```

```
                                                            <ul class="range-labels"
id="feel_range_labels">
                                                                    <li>-5</li>
                                                                    <li>-4</li>
                                                                    <li>-3</li>
                                                                    <li>-2</li>
                                                                    <li>-1</li>
                                                                    <li class="active
selected">0</li>
                                                                    <li>1</li>
                                                                    <li>2</li>
                                                                    <li>3</li>
                                                                    <li>4</li>
                                                                    <li>5</li>
                                                            </ul>
                                                    </div>
                                            </div>
                                            <!-- /feel level -->
                                            <!-- polarity, emotionality -->
                                            <input type="hidden" class="form-control"
name="interest" id="interest_input" value="5">
                                            <input type="hidden" class="form-control"
name="feel" id="feel_input" value="0">

                                            <div class="col-sm-8 col-sm-offset-2">
                                            <?php if ($lang == 'en'):?>
                                                    <div class="row">
                                                            <button type="submit"
class="btn btn-block btn-default" id="show_btn">SHOW ME VIDEOS!</button>
                                                    </div>

                                                    <div class="row">
                                                            <button type="button"
class="btn btn-block btn-default" id="back_btn">TAKE ME BACK</button>
                                                    </div>
                                            <?php elseif ($lang == 'sp'):?>
```

```
                                                    <div class="row">
                                                            <button type="submit"
class="btn btn-block btn-default" id="show_btn">¡MOSTRAR VIDEOS!</button>
                                                    </div>

                                                    <div class="row">
                                                            <button type="button"
class="btn btn-block btn-default" id="back_btn">REGRESAR</button>
                                                    </div>
                                            <?php endif; ?>
                                            </div>
                                    </form>
                            </div>
                    </div>
            </div>
            <script type="text/javascript">
                    //reset initial range slider values
                    $(document).ready(function(){
                            $('#feel_slider').val(0);
                            $('#interest_slider').val(5);
                    })

                    function sliderChange1(val){
                            $('#interest_input').val(val);
                    }

                    function sliderChange2(val){
                            $('#feel_input').val(val);
                    }
    </script>
    <!-- get country names in select -->
            <script>
                    var lang = "<?php echo $lang; ?>";
                    $.ajax({
                            type: 'POST',
                            dataType: 'json',
```

```
                            url: 'get_country.php',
                            success: function(result) {
                                console.log(result);
                                var count = result.length;
                                var res="";

                                if (lang == 'en') {
                                     var res = "<option value='' selected='selected'
disabled='disabled'>country</option>";
                                }
                                else if (lang == 'sp') {
                                     var res = "<option value='' selected='selected'
disabled='disabled'>país</option>";
                                }
                                for (var i = 0; i < count; i++) {
                                         res += "<option value='" + result[i].Country +
"'>" + result[i].Country + "</option>";
                                }
                                $('#select_country').html(res);
                            }
                  });
         </script>
         <script>
                  var prefix = "<?php echo $prefix; ?>";

                  $('#back_btn').click(function() {
                            window.location.href = prefix + "index.php";
                  })
         </script>
         <script src="js/rangeslider.js"></script>
</body>
</html>
```

Reorder_video (modifies the order of the videos according to watching time by the user).

```
<?php
        session_start();
        $lang = $_SESSION['lang'];

        $occupation = $_POST['occupation'];
        $field = $_POST['field'];
        $country = $_POST['country'];
        $interest = $_POST['interest'];
        $feel = $_POST['feel'];
        $user = $_POST['user'];
        $interested_num = $_POST['interested_num'];
        $indecisive_num = $_POST['indecisive_num'];
        $uninterested_num = $_POST['uninterested_num'];

        include("config.php");
        include("httpful.phar");

        $mysqli = new mysqli($host, $username, $password, $database);

        //polarity_vector
        $polarity_v = array(0, 0, 0, 0, 0, 0, 0);//7 elements

        switch ($user) {
                case 'interested':
                        $polarity_v[$interested_num] = 1;
                        break;
                case 'indecisive':
                        $polarity_v[$indecisive_num] = 1;
                        break;
                case 'uninterested':
                        $polarity_v[$uninterested_num] = 1;
                        break;
                default:
                        $polarity_v[1] = 1;
```

```
}

//occupation_vector
$occupation_v = array(0, 0, 0, 0, 0, 0, 0, 0, 0);//9 elements
switch ($occupation) {
         case 'business':
                  $occupation_v[0] = 1;
                  break;
         case 'designers':
                  $occupation_v[1] = 1;
                  break;
         case 'education':
                  $occupation_v[2] = 1;
                  break;
         case 'government':
                  $occupation_v[3] = 1;
                  break;
         case 'none':
                  $occupation_v[4] = 1;
                  break;
         case 'others':
                  $occupation_v[5] = 1;
                  break;
         case 'professors':
                  $occupation_v[6] = 1;
                  break;
         case 'research':
                  $occupation_v[7] = 1;
                  break;
         case 'students':
                  $occupation_v[8] = 1;
                  break;
         default:
                  $occupation_v[0] = 1;
}
```

```
//expertise field_vector
$field_v = array(0, 0, 0, 0, 0, 0);//6 elements
switch ($field) {
        case 'architecture':
                $field_v[0] = 1;
                break;
        case 'engineering':
                $field_v[1] = 1;
                break;
        case 'general':
                $field_v[2] = 1;
                break;
        case 'graphicdesign':
                $field_v[3] = 1;
                break;
        case 'industrialdesign':
                $field_v[4] = 1;
                break;
        case 'mixed':
                $field_v[5] = 1;
                break;
        default:
                $field_v[0] = 1;
}

//country_vector
$query_country = "SELECT DISTINCT Continent FROM continent_country WHERE
Country='".$_POST['country']."'";
$result_country = $mysqli->query($query_country);
$row_country = $result_country->fetch_assoc();
$continent = $row_country['Continent'];

$country_v = array(0, 0, 0, 0, 0, 0, 0, 0);//8 elements

switch ($continent) {
        case 'africa':
```

```
                        $country_v[0] = 1;
                        break;
                case 'asia':
                        $country_v[1] = 1;
                        break;
                case 'europe':
                        $country_v[2] = 1;
                        break;
                case 'latinamerica':
                        $country_v[3] = 1;
                        break;
                case 'northamerica':
                        $country_v[4] = 1;
                        break;
                case 'oceania':
                        $country_v[5] = 1;
                        break;
                case 'southasia':
                        $country_v[6] = 1;
                        break;
                case 'undisclosed':
                        $country_v[7] = 1;
                        break;
                default:
                        $country_v[0] = 1;
        }

        if ($lang == 'en')
                // print_r($polarity_v);
                $query = "CALL ReorderVideoEn($occupation_v[0], $occupation_v[1],
$occupation_v[2], $occupation_v[3], $occupation_v[4], $occupation_v[5],
$occupation_v[6], $occupation_v[7], $occupation_v[8], $field_v[0], $field_v[1],
$field_v[2], $field_v[3], $field_v[4], $field_v[5], $country_v[0], $country_v[1],
$country_v[2], $country_v[3], $country_v[4], $country_v[5], $country_v[6],
$country_v[7], $interest, $feel, $polarity_v[0], $polarity_v[1], $polarity_v[2],
$polarity_v[3], $polarity_v[4], $polarity_v[5], $polarity_v[6])";
```

```
        elseif ($lang == 'sp')
                $query = "CALL ReorderVideoSp($occupation_v[0], $occupation_v[1],
$occupation_v[2], $occupation_v[3], $occupation_v[4], $occupation_v[5],
$occupation_v[6], $occupation_v[7], $occupation_v[8], $field_v[0], $field_v[1],
$field_v[2], $field_v[3], $field_v[4], $field_v[5], $country_v[0], $country_v[1],
$country_v[2], $country_v[3], $country_v[4], $country_v[5], $country_v[6],
$country_v[7], $interest, $feel, $polarity_v[0], $polarity_v[1], $polarity_v[2],
$polarity_v[3], $polarity_v[4], $polarity_v[5], $polarity_v[6])";

        $result = $mysqli->query($query);
        $video_res = array();
        $youtubeVidIds = array();

        while ($row = $result->fetch_assoc()) {
                $video_res[] = $row;
                $youtubeVidIds[] = $row['video_id'];
        }

        $response =
¥Httpful¥Request::get("https://www.googleapis.com/youtube/v3/videos?key=AIzaSyCWW3BpLalo
Eep0vTHf5_zoO8mxQGRzOsA&part=snippet&id=".implode (",",$youtubeVidIds)."")->send();

        $response = json_decode($response);
        $data = array('video'=>$video_res, 'thumbnail'=>$response);

        header('Content-type: text/json');

        echo json_encode($data);
?>
```

Annex 30. Survey 1 for Evaluation of Educational Intervention (English Version)

Instructions: Please answer the following questions. There are no right or wrong answers. All opinions are welcome.

---

*1. Do you know what is Sustainable Design?

- No (Proceed to Question 4)
- Yes

2. Please explain what is Sustainable Design.

3. How many times have you done Sustainable Design projects in the past? Please answer with numbers.

*4. Please rate how much interest do you have in Sustainable Design:

0 (Not Interested) to **10 (Very Interested)**

*5. How does Sustainable Design make you feel?

*6. Overall, how do you feel about Sustainable Design?

-5 (Bad) **0 (Neutral)** **5 (Good)**

Annex 31. Survey 2 for Evaluation of Educational Intervention (Spanish Version)

Por favor responde las siguientes preguntas. No hay respuestas correctas o incorrectas. Todas las opiniones son bienvenidas.

*1. *¿Sabes qué es el Diseño Sustentable?*

- No (Procede con la pregunta 4)
- Sí

2. Por favor explica qué es el Diseño Sustentable.

3. ¿Cuántas veces has participado en proyectos de Diseño Sustentable en el pasado?

*4. *Por favor marca cuánto interés tienes en el Diseño Sustentable:*

0 (Ningún Interés) **10 (Mucho Interés)**

*5. *¿Cómo te hace sentir el Diseño Sustentable?*

*6. *En general ¿Cómo te hace sentir el Diseño Sustentable?*

-5 (Mal) **0 (Neutral)** **5 (Bien)**

Annex 32. Survey 2 for Evaluation of Educational Intervention After Watching Videos (English Version)

Please answer the following questions. There are no right or wrong answers. All opinions are welcome.

1. Please describe what happened during the activity.

2. What did you feel during the activity?

3. Overall, how did you feel during the activity?

-5 (Bad) **0 (Neutral)** **5 (Good)**

4. Please describe what Sustainable Design is to you now.

5. Please rate how much interest do you have in Sustainable Design now:

0 (Not Interested) **10 (Very Interested)**

Annex 33. Survey 2 for Evaluation of Educational Intervention After Watching Videos (Spanish Version)

Por favor responde las siguientes preguntas. No hay respuestas correctas o incorrectas. Todas las opiniones son bienvenidas.

1. Por favor describe qué pasó durante la actividad.

2. ¿Cómo te sentiste durante la actividad?

3. En general ¿Cómo te sentiste durante la actividad?

-5 (Mal) **0 (Neutral)** **5 (Bien)**

4. Por favor describe qué es el Diseño Sustentable para ti ahora.

5. Por favor marca cuánto interés tienes en el Diseño Sustentable ahora:

0 (Ningún Interés) **10 (Mucho Interés)**

Annex 34. Survey 3 for Evaluation of Educational Intervention 2 Months Later for No Intervention and Half Intervention Groups (English Version)

Please answer the following questions. There are no right or wrong answers. All opinions are welcome.

1. Please explain what is Sustainable Design.

2. How many times have you done Sustainable Design projects in the past two months? (please answer with numbers)

3. Please answer this question ONLY if you replied "0 times".
If not, proceed to question 4.
How does Sustainable Design make you feel?

4. Please answer this question
ONLY if you have participated in Sustainable Design projects in the last 2 months:
How did you feel when you were doing Sustainable Design?

5. Overall, how do you feel about Sustainable Design?

-5 (Bad) **0 (Neutral)** **5 (Good)**

6. Please rate how much interest do you have in Sustainable Design now:

0 (Not Interested) **10 (Very Interested)**

Annex 35. Survey 3 for Evaluation of Educational Intervention 2 Months Later for No Intervention and Half Intervention Groups (Spanish Version)

Por favor responde las siguientes preguntas. No hay respuestas correctas o incorrectas. Todas las opiniones son bienvenidas.

1. Por favor explica qué es el Diseño Sustentable.

2. ¿Cuántas veces has participado en proyectos de Diseño Sustentable en los últimos dos meses? (por favor responde con números)

3. Por favor responde esta pregunta SOLAMENTE si respondiste "0 veces".
Si no, procede a la pregunta número 4.
¿Cómo te hace sentir el Diseño Sustentable?

4. Por favor responde esta pregunta
SOLAMENTE si participaste en proyectos de Diseño Sustentable en los últimos 2 meses:
¿Cómo te sentiste haciendo Diseño Sustentable?

****5. En general, ¿Cómo te hace sentir el Diseño Sustentable?***

-5 (Mal)	**0 (Neutral)**	**5 (Bien)**

****6. Por favor marca cuánto interés tienes en el Diseño Sustentable:***

0 (Ningún Interés)	**10 (Mucho Interés)**

Annex 36. Survey 3 for Evaluation of Educational Intervention 2 Months Later for Full Intervention Group (English Version)

Please answer the following questions. There are no right or wrong answers. All opinions are welcome.

****1. Please explain what is Sustainable Design.***

****2. How many times have you done Sustainable Design projects in the past two months? (please answer with numbers)***

3. Please answer this question ONLY if you replied "0 times".
If not, proceed to question 4.
How does Sustainable Design make you feel?

4. Please answer this question
ONLY if you have participated in Sustainable Design projects in the last 2 months:
How did you feel when you were doing Sustainable Design?

**5. Overall, how do you feel about Sustainable Design?*

-5 (Bad)	0 (Neutral)	5 (Good)

**6. Did you encounter any obstacles to do Sustainable Design that you did not consider in the activity we had?*
If you did, please describe them.

**7. Please rate how much interest do you have in Sustainable Design now:*

0 (Not Interested)	10 (Very Interested)

Annex 37. Survey 3 for Evaluation of Educational Intervention 2 Months Later for Full Intervention Group (Spanish Version)

Por favor responde las siguientes preguntas. No hay respuestas correctas o incorrectas. Todas las opiniones son bienvenidas.

****1. Por favor explica qué es el Diseño Sustentable.***

****2. ¿Cuántas veces has participado en proyectos de Diseño Sustentable en los últimos dos meses? (por favor responde con números)***

3. Por favor responde esta pregunta SOLAMENTE si respondiste "0 veces".
Si no, procede a la pregunta número 4.
¿Cómo te hace sentir el Diseño Sustentable?

4. Por favor responde esta pregunta SOLAMENTE si participaste en proyectos de Diseño Sustentable en los últimos 2 meses:
¿Cómo te sentiste haciendo Diseño Sustentable?

****5. En general, ¿Cómo te hace sentir el Diseño Sustentable?***

-5 (Mal) **0 (Neutral)** **5 (Bien)**

6. ¿Encontraste obstáculos para hacer Diseño Sustentable que no consideraste durante la actividad de hace dos meses?
Si fue así, por favor descríbelos.

7. Por favor marca cuánto interés tienes en el Diseño Sustentable:

0 (Ningún Interés) **10 (Mucho Interés)**

Annex 38. Mann-Whitney U Test According to Treatment Groups

Variable		N	Mean Rank	Sum of Ranks	Mann-Whitney U	Asymp. Sig. (2-tailed)
Age	No Intervention	10	19.95	199.50		
	Intervention	22	14.93	328.50		
	Total	32			75.500	.158
Occupation_Business	No Intervention	10	17.10	171.00		
	Intervention	22	16.23	357.00		
	Total	32			104.000	.561
Occupation_Designers	No Intervention	10	18.10	181.00		
	Intervention	22	15.77	347.00		
	Total	32			94.000	.453
Occupation_Government	No Intervention	10	16.00	160.00		
	Intervention	22	16.73	368.00		
	Total	32			105.000	.500
Occupation_Professors	No Intervention	10	16.10	161.00		
	Intervention	22	16.68	367.00		
	Total	32			106.000	.777
Occupation_Research	No Intervention	10	14.10	141.00		
	Intervention	22	17.59	387.00		
	Total	32			86.000	.193

Occupation_Students	No Intervention	10	15.30	153.00		
	Intervention	22	17.05	375.00		
	Total	32			98.000	.395
Expertise_Architecture	No Intervention	10	14.50	145.00		
	Intervention	22	17.41	383.00		
	Total	32			90.000	.156
Expertise_GraphicDesign	No Intervention	10	18.40	184.00		
	Intervention	22	15.64	344.00		
	Total	32			91.000	.321
Expertise_IndustrialDesign	No Intervention	10	15.20	152.00		
	Intervention	22	17.09	376.00		
	Total	32			97.000	.498
Expertise_General	No Intervention	10	17.60	176.00		
	Intervention	22	16.00	352.00		
	Total	32			99.000	.138
Expertise_Mixed	No Intervention	10	16.80	168.00		
	Intervention	22	16.36	360.00		
	Total	32			107.000	.876
Gender_Other	No Intervention	10	18.10	181.00		
	Intervention	22	15.77	347.00		
	Total	32			94.000	.453
Gender_Male	No Intervention	10	14.90	149.00		
	Intervention	22	17.23	379.00		
	Total	32			94.000	.453
Nationality_Asia	No Intervention	10	17.50	175.00		
	Intervention	22	16.05	353.00		
	Total	32			100.000	.636
Nationality_Europe	No Intervention	10	15.60	156.00		
	Intervention	22	16.91	372.00		
	Total	32			101.000	.561
Nationality_Latinamerica	No Intervention	10	15.30	153.00		

	Intervention	22	17.05	375.00		
	Total	32			98.000	.561
Nationality_Northamerica	No Intervention	10	17.60	176.00		
	Intervention	22	16.00	352.00		
	Total	32			99.000	.138
Language_English	No Intervention	10	17.70	177.00		
	Intervention	22	15.95	351.00		
	Total	32			98.000	.561
Language_Spanish	No Intervention	10	15.30	153.00		
	Intervention	22	17.05	375.00		
	Total	32			98.000	.561
Knowledge about Sustainable Design_Yes	No Intervention	10	13.20	132.00		
	Intervention	22	18.00	396.00		
	Total	32			77.000	.115
Knowledge about Sustainable Design_No	No Intervention	10	19.80	198.00		
	Intervention	22	15.00	330.00		
	Total	32			77.000	.115
Sustainable Design Concept Length	No Intervention	10	12.85	128.50		
	Intervention	22	18.16	399.50		
	Total	32			73.500	.095
Number of Sustainable Design Projects	No Intervention	10	15.30	153.00		
	Intervention	22	17.05	375.00		
	Total	32			98.000	.474
Interest	No Intervention	10	13.60	136.00		
	Intervention	22	17.82	392.00		
	Total	32			81.000	.221
SentiStrength Positive Sentiment	No Intervention	10	13.50	135.00		
	Intervention	22	17.86	393.00		
	Total	32			80.000	.178
SentiStrength Negative Sentiment	No Intervention	10	17.95	179.50		
	Intervention	22	15.84	348.50		
	Total	32			95.500	.385

SentiStrength Sentiment Sum	No Intervention	10	15.25	152.50		
	Intervention	22	17.07	375.50		
	Total	32			97.500	.584
Emotionality	No Intervention	10	12.40	124.00		
	Intervention	22	18.36	404.00		
	Total	32			69.000	.076
Sentiment Likert Scale	No Intervention	10	14.65	146.50		
	Intervention	22	17.34	381.50		
	Total	32			91.500	.445
Sustainable Design Concept Length After the Intervention	No Intervention	10	16.80	168.00		
	Intervention	22	16.36	360.00		
	Total	32			107.000	.903
SentiStrength Positive Sentiment After the Intervention	No Intervention	10	15.95	159.50		
	Intervention	22	16.75	368.50		
	Total	32			104.500	.812
SentiStrength Negative Sentiment After the Intervention	No Intervention	10	18.15	181.50		
	Intervention	22	15.75	346.50		
	Total	32			93.500	.434
SentiStrength Sentiment Sum After the Intervention	No Intervention	10	17.00	170.00		
	Intervention	22	16.27	358.00		
	Total	32			105.000	.830
Emotionality After the Intervention	No Intervention	10	14.60	146.00		
	Intervention	22	17.36	382.00		
	Total	32			91.000	.419
Sentiment Likert Scale After the Intervention	No Intervention	10	17.80	178.00		
	Intervention	22	15.91	350.00		
	Total	32			97.000	.586
Interest After the Intervention	No Intervention	10	17.30	173.00		
	Intervention	22	16.14	355.00		
	Total	32			102.000	.738
	No Intervention	10	16.65	166.50		

Sustainable Design Concept 2 Months Later	Intervention	22	16.43	361.50		
	Total	32			108.500	.951
Number of Projects 2 Months Later	No Intervention	10	13.00	130.00		
	Intervention	22	18.09	398.00		
	Total	32			75.000	.049*
SentiStrength Positive Sentiment 2 Months Later	No Intervention	10	13.95	139.50		
	Intervention	22	17.66	388.50		
	Total	32			84.500	.218
SentiStrength Negative Sentiment 2 Months Later	No Intervention	10	17.15	171.50		
	Intervention	22	16.20	356.50		
	Total	32			103.500	.752
SentiStrength Sum 2 Months Later	No Intervention	10	15.70	157.00		
	Intervention	22	16.86	371.00		
	Total	32			102.000	.714
Sentiment Emotionality 2 Months Later	No Intervention	10	13.80	138.00		
	Intervention	22	17.73	390.00		
	Total	32			83.000	.230
Sentiment Likert Scale 2 Months Later	No Intervention	10	19.45	194.50		
	Intervention	22	15.16	333.50		
	Total	32			80.500	.214
Interest 2 Months Later	No Intervention	10	13.55	135.50		
	Intervention	22	17.84	392.50		
	Total	32			80.500	.212

Annex 39. Mann-Whitney U Test According to Language

Language		N	Mean Rank	Sum of Ranks	Mann-Whitney U	Asymp. Sig. (2-tailed)
Age	English	20	16.15	323.00		
	Spanish	12	17.08	205.00		
	Total	32			113.000	.784
Occupation_Business	English	20	17.10	342.00		
	Spanish	12	15.50	186.00		

	Total	32			108.000	.265
Occupation_Designers	English	20	17.30	346.00		
	Spanish	12	15.17	182.00		
	Total	32			104.000	.472
Occupation_Government	English	20	16.80	336.00		
	Spanish	12	16.00	192.00		
	Total	32			114.000	.439
Occupation_Professors	English	20	16.10	322.00		
	Spanish	12	17.17	206.00		
	Total	32			112.000	.587
Occupation_Research	English	20	17.30	346.00		
	Spanish	12	15.17	182.00		
	Total	32			104.000	.407
Occupation_Students	English	20	16.90	338.00		
	Spanish	12	15.83	190.00		
	Total	32			112.000	.587
Expertise_Architecture	English	20	15.30	306.00		
	Spanish	12	18.50	222.00		
	Total	32			96.000	.103
Expertise_GraphicDesign	English	20	15.20	304.00		
	Spanish	12	18.67	224.00		
	Total	32			94.000	.194
Expertise_IndustrialDesign	English	20	18.40	368.00		
	Spanish	12	13.33	160.00		
	Total	32			82.000	.058
Expertise_General	English	20	16.00	320.00		
	Spanish	12	17.33	208.00		
	Total	32			110.000	.197
Expertise_Mixed	English	20	17.60	352.00		
	Spanish	12	14.67	176.00		
	Total	32			98.000	.272
Gender_Other	English	20	15.70	314.00		
	Spanish	12	17.83	214.00		
	Total	32			104.000	.472
Gender_Male	English	20	17.30	346.00		

	Spanish	12	15.17	182.00		
	Total	32			104.000	.472
Nationality_Asia	English	20	19.90	398.00		
	Spanish	12	10.83	130.00		
	Total	32			52.000	.002*
Nationality_Europe	English	20	18.00	360.00		
	Spanish	12	14.00	168.00		
	Total	32			90.000	.063
Nationality_Latinamerica	English	20	11.30	226.00		
	Spanish	12	25.17	302.00		
	Total	32			16.000	.000*
Nationality_Northamerica	English	20	16.80	336.00		
	Spanish	12	16.00	192.00		
	Total	32			114.000	.439
Knowledge about Sustainable Design_Yes	English	20	13.20	264.00		
	Spanish	12	22.00	264.00		
	Total	32			54.000	.003*
Knowledge about Sustainable Design_No	English	20	19.80	396.00		
	Spanish	12	11.00	132.00		
	Total	32			54.000	.003*
Sustainable Design Concept Length	English	20	13.33	266.50		
	Spanish	12	21.79	261.50		
	Total	32			56.500	.005*
Number of Sustainable Design Projects	English	20	14.40	288.00		
	Spanish	12	20.00	240.00		
	Total	32			78.000	.016*
Interest	English	20	15.80	316.00		
	Spanish	12	17.67	212.00		
	Total	32			106.000	.571
SentiStrength Positive Sentiment	English	20	14.90	298.00		
	Spanish	12	19.17	230.00		
	Total	32			88.000	.169
SentiStrength Negative Sentiment	English	20	16.40	328.00		
	Spanish	12	16.67	200.00		
	Total	32			118.000	.909

SentiStrength Sentiment Sum	English	20	14.98	299.50		
	Spanish	12	19.04	228.50		
	Total	32			89.500	.201
Emotionality	English	20	14.63	292.50		
	Spanish	12	19.63	235.50		
	Total	32			82.500	.120
Sentiment Likert Scale	English	20	16.50	330.00		
	Spanish	12	16.50	198.00		
	Total	32			120.000	1.000
Sustainable Design Concept Length After the Intervention	English	20	15.73	314.50		
	Spanish	12	17.79	213.50		
	Total	32			104.500	.546
SentiStrength Positive Sentiment After the Intervention	English	20	14.18	283.50		
	Spanish	12	20.38	244.50		
	Total	32			73.500	.054
SentiStrength Negative Sentiment After the Intervention	English	20	18.88	377.50		
	Spanish	12	12.54	150.50		
	Total	32			72.500	.031*
SentiStrength Sentiment Sum After the Intervention	English	20	15.95	319.00		
	Spanish	12	17.42	209.00		
	Total	32			109.000	.651
Emotionality After the Intervention	English	20	12.93	258.50		
	Spanish	12	22.46	269.50		
	Total	32			48.500	.004*
Sentiment Likert Scale After the Intervention	English	20	19.43	388.50		
	Spanish	12	11.63	139.50		
	Total	32			61.500	.019*
Interest After the Intervention	English	20	14.03	280.50		
	Spanish	12	20.63	247.50		
	Total	32			70.500	.047*
Sustainable Design Concept 2 Months Later	English	20	15.60	312.00		
	Spanish	12	18.00	216.00		
	Total	32			102.000	.482
Number of Projects 2 Months Later	English	20	17.00	340.00		
	Spanish	12	15.67	188.00		

	Total	32			110.000	.590
SentiSrength Positive Sentiment 2 Months Later	English	20	15.15	303.00		
	Spanish	12	18.75	225.00		
	Total	32			93.000	.212
SentiStrength Negative Sentiment 2 Months Later	English	20	14.98	299.50		
	Spanish	12	19.04	228.50		
	Total	32			89.500	.157
SentiStrength Sum 2 Months Later	English	20	14.15	283.00		
	Spanish	12	20.42	245.00		
	Total	32			73.000	.039*
Sentiment Emotionality 2 Months Later	English	20	16.23	324.50		
	Spanish	12	16.96	203.50		
	Total	32			114.500	.815
Sentiment Likert Scale 2 Months Later	English	20	16.20	324.00		
	Spanish	12	17.00	204.00		
	Total	32			114.000	.809
Interest 2 Months Later	English	20	16.63	332.50		
	Spanish	12	16.29	195.50		
	Total	32			117.500	.919

Annex 40. Mann-Whitney U Test in Eye Tracking Data According to Treatment Groups

Variable	Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Asymp. Sig. (2-tailed)
Videos Number	YouTube Users	8	9.13	73.00		
	Rec. Sys. Users	10	9.80	98.00		
	Total	18			37.000	.786
Video Watching Time	YouTube Users	8	6.50	52.00		
	Rec. Sys. Users	10	11.90	119.00		
	Total	18			16.000	.033*
Design Objects Watching Time	YouTube Users	8	6.50	52.00		
	Rec. Sys. Users	10	11.90	119.00		
	Total	18			16.000	.033*
Humans Watching Time	YouTube Users	8	9.13	73.00		
	Rec. Sys. Users	10	9.80	98.00		
	Total	18			37.000	.790

Living Beings Watching Time	YouTube Users	8	11.38	91.00		
	Rec. Sys. Users	10	8.00	80.00		
	Total	18			25.000	.183
Environment Watching Time	YouTube Users	8	9.63	77.00		
	Rec. Sys. Users	10	9.40	94.00		
	Total	18			39.000	.929
Money Watching Time	YouTube Users	8	11.31	90.50		
	Rec. Sys. Users	10	8.05	80.50		
	Total	18			25.500	.125
Average of Design Objects Watching Time	YouTube Users	8	7.50	60.00		
	Rec. Sys. Users	10	11.10	111.00		
	Total	18			24.000	.155
Average of Humans Watching Time	YouTube Users	8	10.38	83.00		
	Rec. Sys. Users	10	8.80	88.00		
	Total	18			33.000	.534
Average of Living Beings Watching Time	YouTube Users	8	11.63	93.00		
	Rec. Sys. Users	10	7.80	78.00		
	Total	18			23.000	.131
Average of Environment Watching Time	YouTube Users	8	10.88	87.00		
	Rec. Sys. Users	10	8.40	84.00		
	Total	18			29.000	.328
Average of Money Watching Time	YouTube Users	8	11.50	92.00		
	Rec. Sys. Users	10	7.90	79.00		
	Total	18			24.000	.090
Video Watching Fixation Time	YouTube Users	8	5.88	47.00		
	Rec. Sys. Users	10	12.40	124.00		
	Total	18			11.000	.010*
Design Objects Fixation Time	YouTube Users	8	7.25	58.00		
	Rec. Sys. Users	10	11.30	113.00		
	Total	18			22.000	.110
Humans Fixation Time	YouTube Users	8	9.25	74.00		
	Rec. Sys. Users	10	9.70	97.00		
	Total	18			38.000	.859
Living Beings Fixation Time	YouTube Users	8	9.69	77.50		
	Rec. Sys. Users	10	9.35	93.50		

	Total	18			38.500	.894
Environment Fixation Time	YouTube Users	8	9.75	78.00		
	Rec. Sys. Users	10	9.30	93.00		
	Total	18			38.000	.859
Money Fixation Time	YouTube Users	8	11.75	94.00		
	Rec. Sys. Users	10	7.70	77.00		
	Total	18			22.000	.043*
Average of Video Watching Fixation Time	YouTube Users	8	9.63	77.00		
	Rec. Sys. Users	10	9.40	94.00		
	Total	18			39.000	.929
Average of Design Objects Fixation Time	YouTube Users	8	8.63	69.00		
	Rec. Sys. Users	10	10.20	102.00		
	Total	18			33.000	.534
Average of Humans Fixation Time	YouTube Users	8	11.00	88.00		
	Rec. Sys. Users	10	8.30	83.00		
	Total	18			28.000	.286
Average of Living Beings Fixation Time	YouTube Users	8	11.19	89.50		
	Rec. Sys. Users	10	8.15	81.50		
	Total	18			26.500	.230
Average of Environment Fixation Time	YouTube Users	8	11.00	88.00		
	Rec. Sys. Users	10	8.30	83.00		
	Total	18			28.000	.286
Average of Money Fixation Time	YouTube Users	8	11.75	94.00		
	Rec. Sys. Users	10	7.70	77.00		
	Total	18			22.000	.043*

Annex 41. Mann-Whitney U Test in Eye Tracking Data According to Language

Variable	Language	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Asymp. Sig. (2-tailed)
Videos Number	English	11	8.91	98.00		
	Spanish	7	10.43	73.00		
	Total	18			32.000	.596[b]
Video Watching Time	English	11	10.18	112.00		
	Spanish	7	8.43	59.00		
	Total	18			31.000	.536[b]

Design Objects Watching Time	English	11	8.91	98.00		
	Spanish	7	10.43	73.00		
	Total	18			32.000	.596[b]
Humans Watching Time	English	11	10.36	114.00		
	Spanish	7	8.14	57.00		
	Total	18			29.000	.425[b]
Living Beings Watching Time	English	11	11.00	121.00		
	Spanish	7	7.14	50.00		
	Total	18			22.000	.151[b]
Environment Watching Time	English	11	9.73	107.00		
	Spanish	7	9.14	64.00		
	Total	18			36.000	.860[b]
Money Watching Time	English	11	9.91	109.00		
	Spanish	7	8.86	62.00		
	Total	18			34.000	.724[b]
Average of Design Objects Watching Time	English	11	8.36	92.00		
	Spanish	7	11.29	79.00		
	Total	18			26.000	.285[b]
Average of Humans Watching Time	English	11	9.45	104.00		
	Spanish	7	9.57	67.00		
	Total	18			38.000	1.000[b]
Average of Living Beings Watching Time	English	11	11.00	121.00		
	Spanish	7	7.14	50.00		
	Total	18			22.000	.151[b]
Average of Environment Watching Time	English	11	9.82	108.00		
	Spanish	7	9.00	63.00		
	Total	18			35.000	.791[b]
Average of Money Watching Time	English	11	9.68	106.50		
	Spanish	7	9.21	64.50		
	Total	18			36.500	.860[b]
Video Watching Fixation Time	English	11	9.18	101.00		
	Spanish	7	10.00	70.00		
	Total	18			35.000	.791[b]
Design Objects Fixation Time	English	11	8.73	96.00		
	Spanish	7	10.71	75.00		

	Total	18			30.000	.479[b]
Humans Fixation Time	English	11	10.00	110.00		
	Spanish	7	8.71	61.00		
	Total	18			33.000	.659[b]
Living Beings Fixation Time	English	11	11.05	121.50		
	Spanish	7	7.07	49.50		
	Total	18			21.500	.126[b]
Environment Fixation Time	English	11	9.55	105.00		
	Spanish	7	9.43	66.00		
	Total	18			38.000	1.000[b]
Money Fixation Time	English	11	9.36	103.00		
	Spanish	7	9.71	68.00		
	Total	18			37.000	.930[b]
Average of Video Watching Fixation Time	English	11	9.00	99.00		
	Spanish	7	10.29	72.00		
	Total	18			33.000	.659[b]
Average of Design Objects Fixation Time	English	11	9.18	101.00		
	Spanish	7	10.00	70.00		
	Total	18			35.000	.791[b]
Average of Humans Fixation Time	English	11	9.36	103.00		
	Spanish	7	9.71	68.00		
	Total	18			37.000	.930[b]
Average of Living Beings Fixation Time	English	11	10.41	114.50		
	Spanish	7	8.07	56.50		
	Total	18			28.500	.375[b]
Average of Environment Fixation Time	English	11	9.82	108.00		
	Spanish	7	9.00	63.00		
	Total	18			35.000	.791[b]
Average of Money Fixation Time	English	11	9.36	103.00		
	Spanish	7	9.71	68.00		
	Total	18			37.000	.930[b]

b Not corrected for ties

Annex 42. Mann-Whitney U Test in Eye Tracking Data According to Asian Nationality

Variable	Nationality	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Asymp. Sig. (2-tailed)
Age	Other	10	11.00	110.00		
	Asian	8	7.63	61.00		
	Total	18			.179	.203[b]
Occupation_Business	Other	10	9.00	90.00		
	Asian	8	10.13	81.00		
	Total	18			.264	.696[b]
Occupation_Designers	Other	10	11.80	118.00		
	Asian	8	6.63	53.00		
	Total	18			.018	.043[b*]
Occupation_Government	Other	10	9.50	95.00		
	Asian	8	9.50	76.00		
	Total	18			1.000	1.000[b]
Occupation_Professors	Other	10	10.70	107.00		
	Asian	8	8.00	64.00		
	Total	18			.099	.315[b]
Occupation_Research	Other	10	9.20	92.00		
	Asian	8	9.88	79.00		
	Total	18			.680	.829[b]
Occupation_Students	Other	10	8.80	88.00		
	Asian	8	10.38	83.00		
	Total	18			.388	.573[b]
Expertise_Architecture	Other	10	10.20	102.00		
	Asian	8	8.63	69.00		
	Total	18			.388	.573[b]
Expertise_GraphicDesign	Other	10	10.20	102.00		
	Asian	8	8.63	69.00		
	Total	18			.388	.573[b]
Expertise_IndustrialDesign	Other	10	8.00	80.00		
	Asian	8	11.38	91.00		
	Total	18			.039	.203[b]
Expertise_General	Other	10	9.90	99.00		
	Asian	8	9.00	72.00		

	Total	18			.371	.762[b]
Expertise_Mixed	Other	10	9.20	92.00		
	Asian	8	9.88	79.00		
	Total	18			.744	.829[b]
Gender_Other	Other	10	8.10	81.00		
	Asian	8	11.25	90.00		
	Total	18			.149	.237[b]
Gender_Male	Other	10	10.90	109.00		
	Asian	8	7.75	62.00		
	Total	18			.149	.237[b]
Knowledge about Sustainable Design_Yes	Other	10	11.80	118.00		
	Asian	8	6.63	53.00		
	Total	18			.018	.043[b*]
Knowledge about Sustainable Design_No	Other	10	7.20	72.00		
	Asian	8	12.38	99.00		
	Total	18			.018	.043[b*]
Sustainable Design Concept Length	Other	10	11.85	118.50		
	Asian	8	6.56	52.50		
	Total	18			.022	.034[b*]
Number of Sustainable Design Projects	Other	10	11.10	111.00		
	Asian	8	7.50	60.00		
	Total	18			.051	.173[b]
Interest	Other	10	11.15	111.50		
	Asian	8	7.44	59.50		
	Total	18			.130	.146[b]
SentiStrength Positive Sentiment	Other	10	11.35	113.50		
	Asian	8	7.19	57.50		
	Total	18			.061	.101[b]
SentiStrength Negative Sentiment	Other	10	9.20	92.00		
	Asian	8	9.88	79.00		
	Total	18			.680	.829[b]
SentiStrength Sentiment Sum	Other	10	10.75	107.50		
	Asian	8	7.94	63.50		
	Total	18			.222	.274[b]
Emotionality	Other	10	11.30	113.00		

	Asian	8	7.25	58.00		
	Total	18			.080	.122b
Sentiment Likert Scale	Other	10	10.35	103.50		
	Asian	8	8.44	67.50		
	Total	18			.436	.460b
Sustainable Design Concept Length After the Intervention	Other	10	12.00	120.00		
	Asian	8	6.38	51.00		
	Total	18			.026	.027b*
SentiStrength Positive Sentiment After the Intervention	Other	10	12.45	124.50		
	Asian	8	5.81	46.50		
	Total	18			.005	.006b*
SentiStrength Negative Sentiment After the Intervention	Other	10	8.40	84.00		
	Asian	8	10.88	87.00		
	Total	18			.255	.360b
SentiStrength Sentiment Sum After the Intervention	Other	10	11.25	112.50		
	Asian	8	7.31	58.50		
	Total	18			.097	.122b
Emotionality After the Intervention	Other	10	12.65	126.50		
	Asian	8	5.56	44.50		
	Total	18			.004	.003b*
Sentiment Likert Scale After the Intervention	Other	10	8.00	80.00		
	Asian	8	11.38	91.00		
	Total	18			.160	.203b
Interest After the Intervention	Other	10	11.30	113.00		
	Asian	8	7.25	58.00		
	Total	18			.086	.122b
Sustainable Design Concept 2 Months Later	Other	10	9.70	97.00		
	Asian	8	9.25	74.00		
	Total	18			.858	.897b
Number of Projects 2 Months Later	Other	10	8.90	89.00		
	Asian	8	10.25	82.00		
	Total	18			.410	.633b
SentiStrength Positive Sentiment 2 Months Later	Other	10	10.20	102.00		
	Asian	8	8.63	69.00		
	Total	18			.455	.573b

SentiStrength Negative Sentiment 2 Months Later	Other	10	11.65	116.50		
	Asian	8	6.81	54.50		
	Total	18			.021	.055[b]
SentiStrength Sum 2 Months Later	Other	10	11.60	116.00		
	Asian	8	6.88	55.00		
	Total	18			.033	.068[b]
Sentiment Emotionality 2 Months Later	Other	10	8.35	83.50		
	Asian	8	10.94	87.50		
	Total	18			.259	.315[b]
Sentiment Likert Scale 2 Months Later	Other	10	9.70	97.00		
	Asian	8	9.25	74.00		
	Total	18			.850	.897[b]
Interest 2 Months Later	Other	10	8.80	88.00		
	Asian	8	10.38	83.00		
	Total	18			.501	.573[b]
VideosNumber	Other	10	8.60	86.00		
	Asian	8	10.63	85.00		
	Total	18			.416	.460[b]
Video Watching Time	Other	10	8.70	87.00		
	Asian	8	10.50	84.00		
	Total	18			.477	.515[b]
Design Objects Watching Time	Other	10	9.70	97.00		
	Asian	8	9.25	74.00		
	Total	18			.859	.897[b]
Humans Watching Time	Other	10	9.80	98.00		
	Asian	8	9.13	73.00		
	Total	18			.790	.829[b]
Living Beings Watching Time	Other	10	6.70	67.00		
	Asian	8	13.00	104.00		
	Total	18			.013	.012[b*]
Environment Watching Time	Other	10	8.60	86.00		
	Asian	8	10.63	85.00		
	Total	18			.424	.460[b]
Money Watching Time	Other	10	8.15	81.50		
	Asian	8	11.19	89.50		

	Total	18			.153	.237b
Average of Design Objects Watching Time	Other	10	10.60	106.00		
	Asian	8	8.13	65.00		
	Total	18			.328	.360b
Average of Humans Watching Time	Other	10	10.80	108.00		
	Asian	8	7.88	63.00		
	Total	18			.248	.274b
Average of Living Beings Watching Time	Other	10	6.90	69.00		
	Asian	8	12.75	102.00		
	Total	18			.021	.021b*
Average of Environment Watching Time	Other	10	8.60	86.00		
	Asian	8	10.63	85.00		
	Total	18			.424	.460b
Average of Money Watching Time	Other	10	8.40	84.00		
	Asian	8	10.88	87.00		
	Total	18			.244	.360b
Video Watching Fixation Time	Other	10	9.10	91.00		
	Asian	8	10.00	80.00		
	Total	18			.722	.762b
Design Objects Fixation Time	Other	10	9.80	98.00		
	Asian	8	9.13	73.00		
	Total	18			.790	.829b
Humans Fixation Time	Other	10	10.10	101.00		
	Asian	8	8.75	70.00		
	Total	18			.594	.633b
Living Beings Fixation Time	Other	10	6.70	67.00		
	Asian	8	13.00	104.00		
	Total	18			.013	.012b*
Environment Fixation Time	Other	10	8.70	87.00		
	Asian	8	10.50	84.00		
	Total	18			.477	.515b
Money Fixation Time	Other	10	8.90	89.00		
	Asian	8	10.25	82.00		
	Total	18			.500	.633b
	Other	10	10.60	106.00		

Video Watching Average Fixation Time	Asian	8	8.13	65.00		
	Total	18			.328	.360[b]
Average of Design Objects Fixation Time	Other	10	10.10	101.00		
	Asian	8	8.75	70.00		
	Total	18			.594	.633[b]
Average of Humans Fixation Time	Other	10	10.80	108.00		
	Asian	8	7.88	63.00		
	Total	18			.248	.274[b]
Average of Living Beings Fixation Time	Other	10	7.60	76.00		
	Asian	8	11.88	95.00		
	Total	18			.091	.101[b]
Average of Environment Fixation Time	Other	10	8.80	88.00		
	Asian	8	10.38	83.00		
	Total	18			.534	.573[b]
Average of Money Fixation Time	Other	10	8.90	89.00		
	Asian	8	10.25	82.00		
	Total	18			.500	.633[b]

b Not corrected for ties.