Colour education in Brazilian universities: a focus on design courses in the state of São Paulo

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The purpose of this study is to address the situation of colour education in higher education design courses, considering the case of Brazil. Brazil has, to date, 2939 institutions offering a total of 53342 higher education courses. Results of our survey showed that in the state of São Paulo, there are 153 design courses, among which 26.8% have an exclusive colour content. This research revealed a panorama of poor higher education curriculum allied with the intuitive and subjective form of applying colour in the designers' profession. Impact and consequences of this panorama result in projects that don't capitalise on colours' potential, considering aspects like spatial perception, advancing and receding colours, wayfinding, legibility, among others. The brief curriculum of the colour module of one design school in São Paulo (ESPM) is given as an example of what may reasonably be considered as the colour content in a higher education course for designers.

Introduction

Colour education in design is much debated and little practiced. After the colourful years of the Bauhaus, where colour was taught by some of the outstanding artists of the age, both art and design courses took Bauhaus colour [1-2] as their inspiration. Albers' *The Interaction of Colors* and Itten's *The Art of Color* are among the textbooks most quoted and used in colour courses for art and design. In one of the most respected design courses of the late 1970's and early 1980', *Basic Principles of Design* of the Basel School of Design, colour was taught by Manfred Maier with the objective that the students master "objective, differentiated knowledge of the appearances, interrelationships, and working criteria of color" [3]. A few years later, Moritz Zwimpfer of the same school declared their aim as "Our basic purpose in teaching the elementary courses on color is to develop and refine the personal color sense of the students" [4]. There is great conceptual difference between the two approaches: whereas Maier focused on practice, Zwimpfer put great emphasis on the theoretical background, including colour physics and psychophysics.

Janssens and Mikellides [5], surveying colour in higher education found a disparity between the colour education that students expected upon entering their courses and the knowledge they actually received. They noted that most of the final-year students reported that very little of their education actually focused on colour.

In our literature survey, we found that out of the 1417 articles published between 1982 and 2017 in 105 issues (35 volumes) of the International Journal of Art and Design Education not one single article had "colour" as a keyword. The same way in the 777 articles published between 1990 and 2017 in 88 issues (27 volumes) of the International Journal of Technology and Design Education not one takes the trouble to even mention "colour education". There is no lack of books on colour theory and practice published for designers, but these are often of very questionable level. It is a bad indicator that 20 interior design courses in the USA and Canada used 17 different textbooks, and only 6 of those contained references to colours in interiors [6].

Current international practice – a brief overview

In 2006, Bantom [6] published the results of a survey based on the evaluation of 96 accredited interior design programs across the USA and Canada. According to her evaluation only half of the 96 design courses had colour content and found many limitations in how colour is being taught. She found that several programs didn't offer a specific subject on colour, or subjects offered were limited to colour theory with no application to design practice, or the contents of colour were only briefly presented in different subjects. She also found that very often lectures and assignments didn't go beyond colour theory, considered mainly the colour wheel, colour harmony, and colour systems. Areas in colour education addressed in their programs. She interviewed 73 students of five colleges and universities and asked the following questions:

1. Has any of your interior design education focused on colour? 89% answered YES
2. Do you think that colour is sufficiently covered in your interior design program? 64 % answered NO
3. If No, which colour subject areas do you think deserve more attention?

Those who indicated that they would like to see additional subject areas in colour education addressed in their programs gave the following answers:
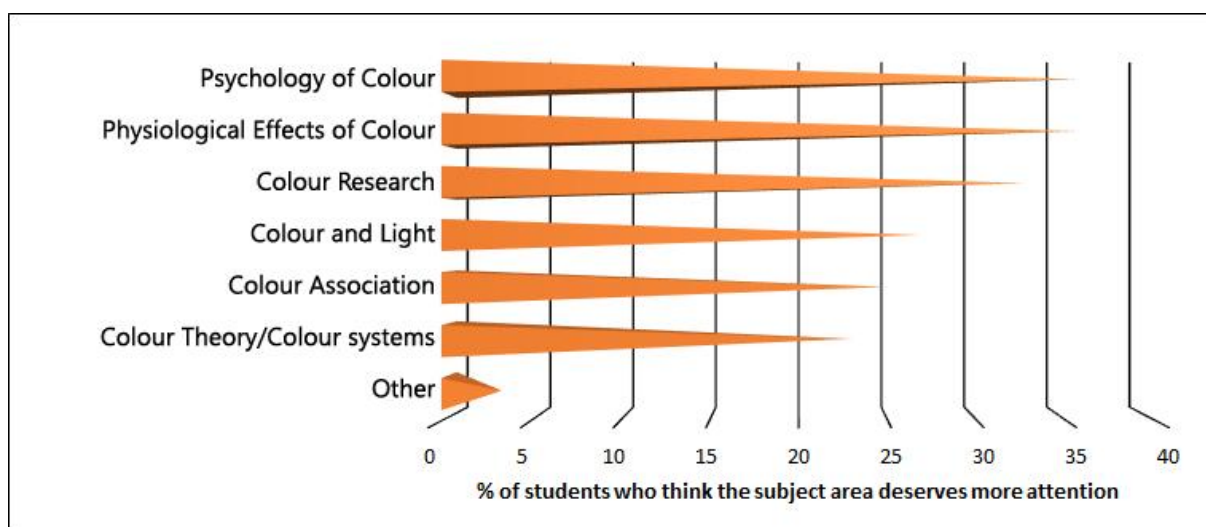

Figure 1: Subject areas of which students would like to get more in their colour education (after Bantom [6]).

According to Bantom's survey those subjects where colour theory is being taught are in art class, and for her this is a problem: "interior design students are being taught colour, but not in the context of interiors, which leaves them at disadvantage upon entering design practice." She interviewed people with specialised colour education, who said that colour design is based on much more sophisticated principles than the designer's taste. Finally, she makes a strong statement that colour education is inconsistent among design programs and often does not cover the application.

Smith [7] made a survey of 26 interior design and architectural companies, from which 16 professionals returned her questionnaires. The major findings related to colour education indicated that 81% of them were educated in colour, i.e. of the 16 architects and interior designers only 3 had not received formal colour education. For 69% colour was a major consideration when they had been beginning designers, but - at that stage - practically none of them employed colour for colour concepts, colour selections, presentation/perspectives or colour schemes. Nevertheless, with one single exception, they all would include colour unit both in architecture and in interior design courses.

Gamito [8] asked a panel of 8 internationally well-known experts (Karin Fridell Anter, Luis Badosa Conill, José Luís Caivano, Jean-Philipe Lenclos, Harold Linton, Frank Mahnke, Byron Mikellides and Pietro Zennaro): which colour fields they considered the most relevant in the courses of industrial design, communication and interior design.
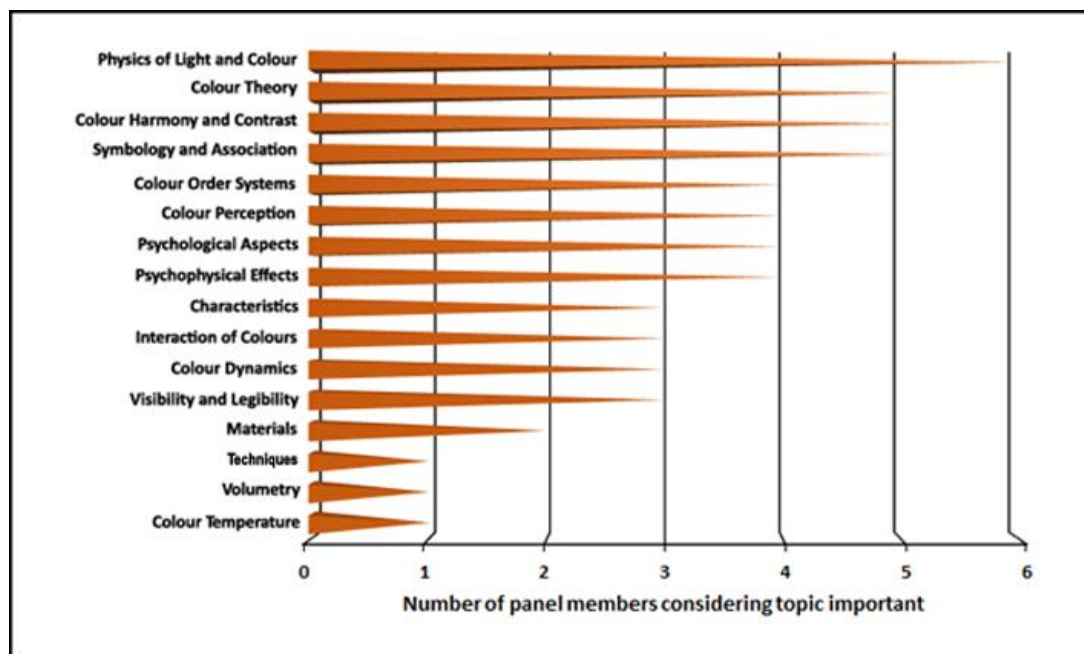

Figure 2: Topics considered important by an international panel (after Gamito [8]).

As may be seen in Figure 2 most of them (75%) mentioned the physics of light and colour as the most important topic to be covered, followed by colour theory, harmony and contrast, symbology and association (62.5%). Colour order systems were considered important by 50%, while illumination only by 12.5%. In the same study students of two design and architecture schools in Portugal were tested for their knowledge of the NCS and the Munsell systems, and the results were rather disappointing.

When comparing the studies of Bantom (Figure 1) and of Gamito (Figure 2) we find a strong dissonance between the subjects that experts deem important: colour physics and colour theory; exactly the subjects that students miss the least in their colour courses. It would need a deep analysis of the content of these courses to discover the reasons for this dissonance; colour physics and colour theory need to be made interesting and easily understandable for design students to want more of it.

Gamito and da Silva [9] found that designers frequently use colour in an intuitive and random way, and that colour is usually considered a matter of taste and a secondary element, not essential to function. They also stated that in communication design colour is usually applied without a real knowledge of its contrast properties and colour interaction, and that often there is no concern about the legibility and integration factors, or the form/ground contrasts.

In O'Connor's opinion [10] the majority of higher education design-focused institutions do not offer colour theory because it would need comprehensive review and revision in terms of embedded theoretical paradigms, ontological assumptions and constructs. He went so far as to ask "why colour theory has a bad name in 21st century design education," presenting reasons behind the impetus to marginalise colour theory and downgrade its status in higher education art, design and architecture curriculum.

This is not to say that today there are no design courses with excellent colour content in many parts of the world. Rizzi *et al.* [11] describe a new master course organised by the Politecnico di Milano and the Università degli Studi di Milano, which "aims to provide in-depth training in the complex field of colour design and technologies, to form professionals able to use colour in creative and industrial processes and in numerous application domains." Jung [12] also reports on a successful BA programme at the Linnaeus University in Sweden, whose aim "is to provide the students with skills to concisely use colour as a tool to make a more efficient design".

The failures and omissions in colour education in design undergraduate courses leave students and future designers with the option of using colours based only on their intuition or personal preference. Csillag [13], interviewing designers and architects, found that these professionals report that their colour choices are based either on their personal preference, or based on colours they think 'that work", or based on their intuition. Csillag [13-15] affirms the importance of dominating the objective perceptual factors in colour contrasts, such as perception of space through colour contrasts. This certainly fills a gap found in the knowledge of colour application in design projects.

Methodology

In 2017 Brazil had 2,939 institutions offering a total of 53,342 higher education courses. Due to this large number this study focused on the state of São Paulo, the economically most significant state in the country. São Paulo covers only 3% of Brazil's more than 8.5 million km2 area, but it has 22% of the population; 25% of the higher education courses and 24% of the more than 5.5 million students enrolled are in São Paulo.

The purpose of this study was thus to address the issue of colour education in higher education design courses, considering the case of the state of São Paulo. The survey intended to determine the proportion of design courses in the state of São Paulo that have a proper colour course, i.e. where it is a subject exclusively dedicated to studying colour as revealed by its title.

This research was conducted using first a quantitative methodology in order to detect in detail all higher education design curriculum matrices in the state of São Paulo. The initial source of information was the official site of the Brazilian Ministry for Education and Culture [16], showing officially accredited courses. After the identification of all the design courses in the state of São Paulo, each course was investigated through their own site and had their curriculum matrix downloaded and analysed in order to identify titles of subjects that contained the word colour. Brazilian law determines that all undergraduate courses must publish on their own website the official curriculum matrix. This research identified only courses that taught colour having an entire dedicated unit for it. It is known, as found in

exploratory findings in this research, and also mentioned by Bantom, as cited above, that several courses cover colour teaching not in a dedicated unit, for example, dedicating only one week for colour theory in a full semester course on art history. Such courses were not considered here, on the one hand due to practical limitations of mapping 184 courses with this type of information that is not published in details on their websites. This could certainly be a subject for further research, constituting one of the research limitations here. On the other hand, the authors strongly believe that studying colour for design applications is so thorough and complex that a dedicated unit is fully justified.

Results and Discussion

Out of the 741 higher education courses in the state of São Paulo we analysed 184 with a design content; among them 23 simply called 'design', others more specifically in the fields of graphic design (45), fashion design (37), interior design (29), digital games and animation (22), industrial and product design (18), digital design (6), and advertising (4).
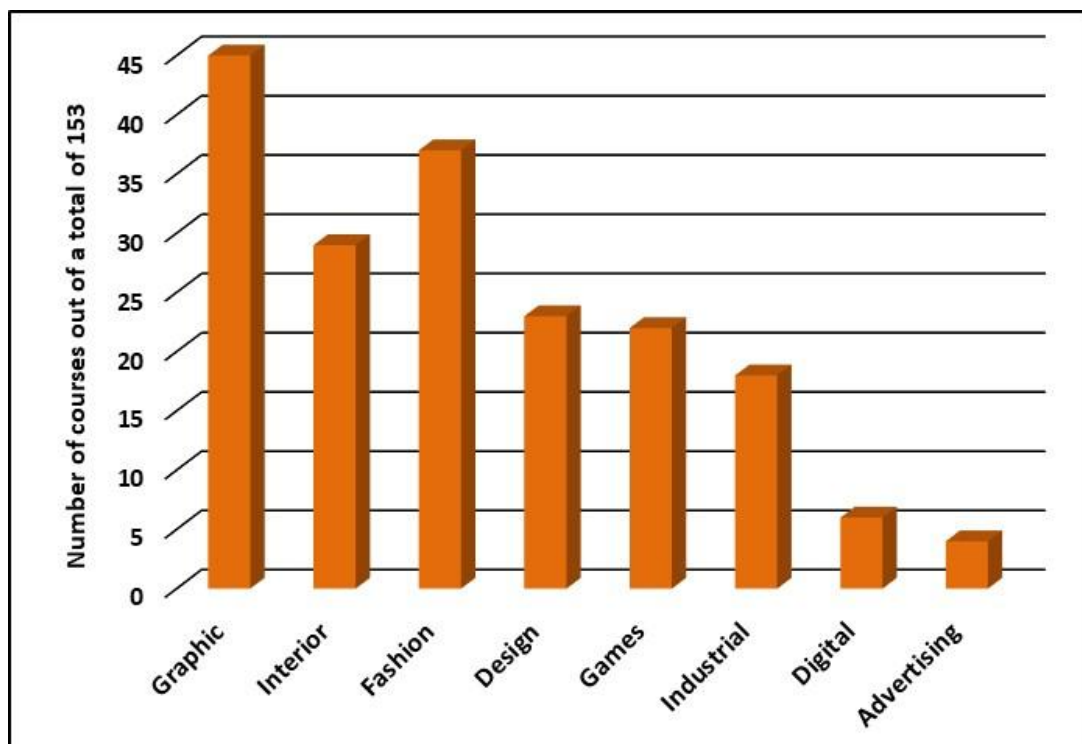
Figure 3: Different areas in the higher education design courses in the state of São Paulo.

We could only perform detailed analysis for 153 of the 184 courses, 31 did not publish if they had any independent colour subject in their curriculum. Figure 4 shows the percentage of courses with colour content. The overall picture is that only 26.8% of all design courses in the state of São Paulo has explicit colour content. Among the design courses interior design has the highest ratio of colour content courses (over 53%), while only 18.5% of fashion design courses teach colour as a separate subject. In the digital games/animation category only 1 in 18 courses teaches colour, which may explain some of those atrocious colours found in video games (for a critical analysis see a study on colours in virtual reality games by Sik-Lányi [17]).
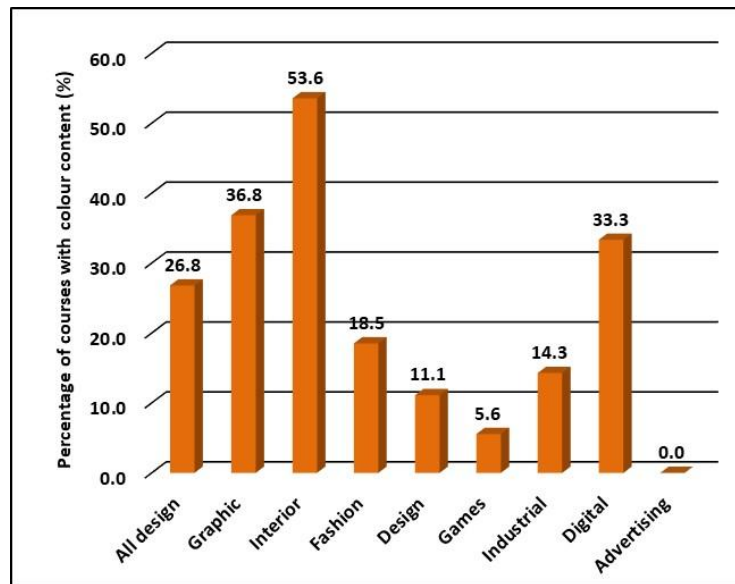
Figure 4: Percentage of HE design courses with colour content.

Upon analysis of all curriculum matrices, and in agreement with the conclusions that may be drawn from the literature, it may be inferred that the teaching of colour is often included in correlated subjects, for example, in History of Art class, usually covering basic contents generally in a week's period. Contents covered in these cases are generally what is considered "Colour Theory", covering items like the colour wheel, colour harmony, colour systems, primary, secondary colours, and complementary colours. Nevertheless, we may ask here: what is the sense in knowing for example, that blue and yellow (or orange) are complementary colours if nothing is said about the application of this contrast of colours and how this contrast specifically may be useful for a certain design intent?

Case study: colour course for designers at ESPM

As a means of offering insights for the structuring of colour courses for design, we shall discuss the colour content for the Undergraduate Course in Visual Design at ESPM University in São Paulo, Brazil. This course is offered at the 3rd semester and has four hours per week. Two hours are dedicated to physical projects, using paints and other physical materials. The other two hours are in a computer laboratory, dedicated to digital projects. Basically, the focus of the course is to offer colour theory connected with the application of the theory to certain design intents, using the pedagogy of Project Based Learning. According to Lupinacci [18], this pedagogy seeks to find interactions between cultural context and institution, where students, teachers, coordinators work objectives, search priorities, map different resources like technology and physical space, and connect with external groups. All this dedicated to creating and applying knowledge for projects, considering: a problem, people/groups, purpose, scope, strategies, means, technologies, results, consequences and impacts. When mentioning design intent, the idea is to determine what a certain design project is communicating chromatically. For example, a design intent could be to communicate calmness, or to communicate vibration. Thus, the colour choices should reflect this intent.

Theory is never presented alone. The course is entirely dedicated to the production of chromatic design projects and theory is presented together with application for each project. One of the main projects is an interdisciplinary project to produce a real magazine. This project is done with the

collaboration of different subjects offered in the same semester, such as Graphic Structure, Marketing and Communication.

One of the colour contents used for the magazine, is to elaborate the colour palette of the magazine, in order to convey a specific mood of the magazine. Figure 5 shows three examples of colour palettes.
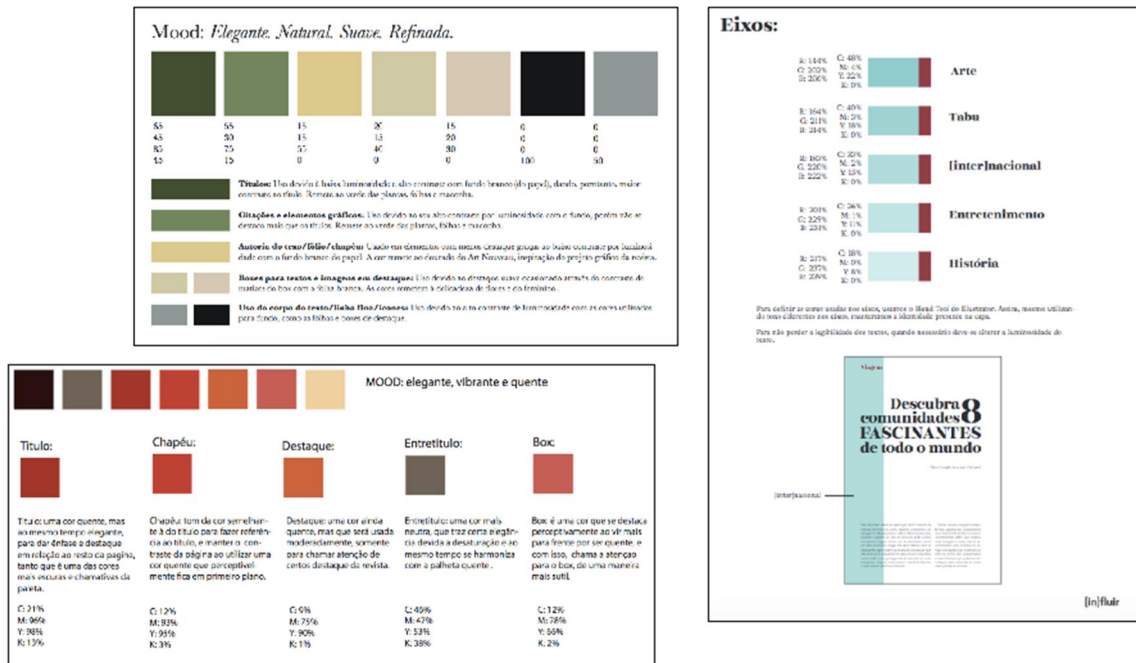

Figure 5: Colour palettes for magazines.

In the magazine, the last section is dedicated to a visual poem designed having in mind the concept of the magazine and colour aspects that enhance this concept. Figure 6, is an example of this project. In this case, the concept of the magazine was to deal with the idea of unconventional beauty and criticise mainstream commercial "hints" for women to become more beautiful. So, this project shows an article (in Portuguese) entitled: "Hints to Lose Weight Before Your Marriage". This text may be read with a red transparent page, working as a red-light filter. When this transparent page is removed from over the text, a red phrase "appears" on the white page text. This red phrase shows a handwritten critic to the text, saying, "But I'm real!".

The Colour Module works on different aspects of this magazine. Each aspect is presented with certain colour theory content, applied directly to the magazine section. For example, when presenting colour theory of light/dark contrast, it is shown how to use this contrast when working with images in a magazine and magazine cover. This contrast should be properly considered having in mind the colour contrasts between text, page colour, image and titles and name of magazine, for covers. Specifically, the lightness of each colour should be investigated, and since it is produced digitally, it is using the brightness aspect digitally with photoshop. This aspect is found in the colour picker window of photoshop, with the Hue, Saturation, Brightness sliders. Figure 7, shows another example of the visual poem project. In this case, the concept of the magazine was to value natural and organic food. The visual poem shows a carrot constructed with words that are names of pesticides. Light/Dark colour theory was here applied, when lightening the green top of the carrot such as to enhance the words of the pesticides, considering that the background is white. If the background were black, the opposite work of dark/light should have been done.

Figure 6 (left): Colour design project using a red filter.
Figure 7 (right): Colour project using light/dark contrast.

Basically, this colour course is organised in two main sections: objective colour communication and subjective colour communication. An example of objective colour communication would be to communicate vibration in terms of the colour contrasts used. Subjective colour communication of the same project would be to communicate a psychedelic idea or otherwise to create interest for kids. Figure 8 shows an example of objective communication of vibration.

Figure 8: Pure hues enhanced with adjacent black. Image © Paula Csillag [13 p77].

Figure 9 shows an example of objective communication of spatial awareness, with an illustration taken from the book Comunicação com Cores [13] that is used as example for students' design projects. The image on the left shows a light background, thus a correct spatial effect occurs using darker colours orderly to the front, and the darkest colour is the one that advances the most. The image on the right, does not show a correct light dark sequence and thus, the spatial effect is not accurate. Students must be aware that this is not a rule, since if the background were dark, the lighter colours would advance.
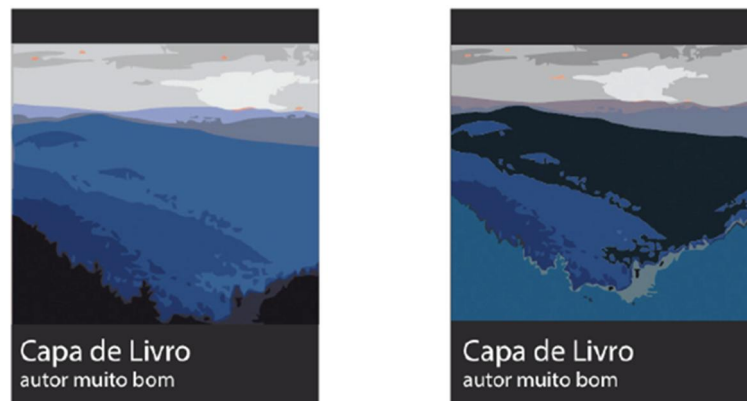

Figure 8: Spatial Effect Created Using Light Dark Contrasts. Image © Paula Csillag [13 p73].

The course contents presented are: Basic Colour Terms and Systems; Objective Colour Perception; Colour Management; Subjective Colour Perception; Colour Harmony; Colour Marketing and Colour in Art. When presenting the Basic Colour Terms and Systems, it is presented, and for some students, merely revised, concepts of CMYK, RGB, wavelengths, colour reflection and concepts of colour physics and perception such as to understand the colour phenomenon.

The content of Objective Colour Perception contains all colour contrasts and colour illusions. Colour illusions and experiments with simultaneous contrasts are worked here in several applied projects. This topic is a lengthy one and covers principles that may be useful for the function in the design project, like wayfinding or perception of space, contrast properties and colour interaction, legibility and integration factors and the figure/ground contrasts.

Next is Colour Management, and that is when the magazine is printed, so student should print their project using Colour Management content learned, such as to minimise any colour distortion. Digital equipment is used and students have the chance of making a real colour profile.

Next content is Subjective Colour Perception. Here the interrelationship between objective and subjective colour perception is discussed as well as the complexities and subtleties of subjective colour perception and communication, such as colour meaning and symbolism. The interrelationship between objective and subjective colour perception is here worked having as a basis the Sen-Org-Int Model. This model, published and awarded in the International Visual Literacy Association's 2007 Book of Selected Readings [19], differentiates the three processes that occur in human perception: sensory impressions, organising processes, and interpretive processes of visual perception. It takes into account psychological approaches to perception, experimental as well as physiological, including findings on neuroscience, and unites these approaches with the traditional visual literacy approaches used in design. With such a framework, applied to colour, professionals dealing with images, can differentiate concepts related to chromatic visual literacy valid as "laws" from those concepts that cannot be generalised to all human beings.

The Sens-Org-Int Model was devised in an attempt to differentiate principles or laws of design that tend to be common to all human beings with normal eyesight from the concepts that are not common

to everyone. Those processes that are common, have a very special importance for designers, due to the communicational value that each may offer. Those that are not common therefore are learned or otherwise acquired, and also have other communicational values [14].

Theories about perception tend to emphasise the role of either sensory data or knowledge in the process. Some theorists have adopted a data-driven or bottom-up stance, or synthetic approach, according to which perception is direct: visual data are immediately structured in the optical array prior to any selectivity on the part of the perceiver proposed by Hering [20], Gestalt theories, and Gibson [21]. Others adopt a constructivist, top-down or analytical approach emphasising the importance of prior knowledge and hypotheses, defended by Berkeley [22], Helmholtz [23], and Bruce, Green & Georgeson [24].

Therefore, the Sens-Org-Int Model unites the synthetic and the analytical approaches to psychology as well as neuroscientific and physiological explanations on how the brain works, and relates these to classical design principles. With this framework, we are then able to tell, from the classical design "laws," which ones can truly be considered a principle valid for all human beings from those that cannot [14].

The next topic is Colour Harmony. Here the known "colour harmony rules" are presented, but also discussed as to how to create harmonies not following "rules". Digital tools are used from illustrator to create a project recolouring an image.

After this topic Colour Marketing is presented. Here aspects of how to use colour taking into account consumer behaviour is showcased. Consumer preferences, considering the subtleties discussed in the Subjective Colour Perception topic, are worked and exemplified with real cases.

And to finalise, Colour in Art is presented, showing how colour was used in completely different manners by different art periods. Poetic use of colour is discussed and worked in a real project.

Therefore, this Colour Module for the Undergraduate Course in Visual Design at ESPM University in São Paulo, Brazil was prepared for students to master the application of colour in real design projects, taking into account colour theory applied to these projects. Colour theory is never presented alone. There is a strong emphasis in principles that may be useful for the function in the design project, like wayfinding or perception of space, contrast properties and colour interaction, legibility and integration factors, or the form/ground contrasts. But these objective aspects are not the only aspects considered. There is an analysis considering the interrelationship of objective and subjective aspects of colour perception in design. This way, students may have basis to prepare real design projects and consider colour concepts and principles in a conscientious manner, not based on intuition or preference.

Conclusions

This study reveals that there is much room for improvement in higher education of colour in design in the state of São Paulo, Brazil. In agreement with O'Connor, it is believed that colour theory for design graduation courses should be revised and updated, to overcome what Smith, Gamito and Csillag mentioned, that designers tend to use colours relying heavily on personal preference, taste or intuition. Impact and consequences of this panorama of poor higher education curriculum allied with the intuitive and subjective form of applying colour in the designers' profession results in projects that don't capitalise on the potential of colours. Several design projects in the State of São Paulo are seen that don't use colour principles that could be useful for the function in the design project, like wayfinding or perception of space; showing lack of knowledge of principles on how to actually apply colours in design projects. Due to image copyright issues we cannot show here these poor examples. Nevertheless,

explorative investigation with graduated students in one of the authors' courses for graduated designers (summer courses) reveal that so much content is missing. These graduated students often mention, using different expressions, when attending the summer Colour Communication Course in São Paulo, "I had no idea there was so much important things to learn about colour!" Hopefully this paper will draw attention to the importance of the formulation and/or restructuring of curriculum matrices in higher education design courses in Brazil and other countries.

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