Colour Knowledge in Design Education

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ABSTRACT: This study is concerned with the level and requirement for colour knowledge (colour theory, colour mixing and colour management) in design education. A total of 73 students engaged in design education took part in an on-line survey to explore their colour knowledge and their views about colour with regard to design. Just over half of the students were able to correctly identify the additive primaries and fewer than half were able to identify the subtractive primaries. The survey also indicated that students' understanding of digital (RGB) colour representation was limited. Despite this, 95% of students responded that colour is critical or very important in design.

1. INTRODUCTION: Colour and form are fundamental components to any design or work of art. Together they make a statement, which may be physical, emotional or spiritual in nature. Its essence is known as the design concept [1]. Each individual colour can establish an association that supports the design statement; the colours seen in combination complete the design. Design involves the resolution of functional needs in association with aesthetic needs of an object. Applied to fashion/textile design, product design or interior design, in each area the function gives context to creative solutions. Fashion or textile design addresses the spirit and visual appearance of the wearer; product design addresses human need; interior design addresses functional issues of human scale etc. the existence of a strong concept during design serves as the frame work for decisions about form, texture, lighting, and to a large degree, colour. Thus, colour is a language and tool that has profound implications for affecting the world. In recently years, there has been an explosion of activity in the field of colour education as new techniques, understanding and areas of expertise have evolved.

Colour education in design is traditionally centered on colour theory. Colour theory encompasses a multitude of definitions, concepts and design applications but includes colour harmony and colour mixing. Colour harmonies, also sometimes called colour schemes, abound in natural and man-made environments. The word "harmony" derives from the Greek harmonia: a fitting together [2]. Arnheim described compositions as simply being either "visually right or wrong" [3]. Art and design education provides an understanding of the formal elements of composition. This awareness, of the elements of composition and design is what Arnheim describes as "visual rightness." Evans explains visual rightness in terms of the simultaneous interaction of the component parts of composition within a given visual space, "as objects in a defined space, expressed, as size, shape, colour and texture establishing dynamic relationships as these elements interact" [4]. Concepts such as visual rightness and balance apply equally well to the notion of colour harmony and that art theorists and practitioners have developed the informed view of which colour combinations are harmonious [5]. Judd described colour harmony in terms of two or more colours seen in neighbouring areas that produce a pleasing effect [6]. When people say that a particular combination is pleasing then

we are not specifying whether it is pleasing because the combination is pleasing *per se* or because it is pleasing in that it achieves its purpose (certain colour designs may be effective – and hence pleasing – because those colours have symbolic meaning, for example, in the specific design context). This raises the question of whether colour harmony is related to the pleasing use of colours in a design or artistic context or whether it refers to special relationships between colours *per se* [7]. Granville notes that colour harmony is about special relationships *per se* in his writes "Colour harmony is colour usage that pleases people" and then that "Fashion and fad are primary arbitrators of colour harmony". Kuehni takes a similar view that there is no doubt that perceptions of beauty and harmony are strongly influenced by nurture and culture so that it is quite evident that there are no universal laws of harmony [8]. Indeed, it has been argued that the articulation of such laws could even be stifling for creativity. In this paper, the main theories of colour harmony will be considered and, in so doing, the question of whether there are any fundamental laws of colour harmony will be considered. Several colour issues are considered to be important to an understanding of the development of ideas in colour harmony and these include the circularity of hue, the nature of colour primaries and the concept of complementary colours. Extreme unity leads to under-stimulation, extreme complexity leads to over-stimulation. Harmony is a dynamic equilibrium [9].

Colour mixing is another important attribute of colour education in art & design. There has been confusion for centuries over the distinction between additive and subtractive colour mixing [5]. LeBlon's discovery and commercialisation of three-colour printing established that red, yellow and blue are the subtractive primaries and has led to a common misconception that all colours can be generated from a mixture of the three primary colours. Not only it is not possible to match all colours using a mixture of red, yellow and blue colorants, these three primaries do not even give the largest colour range (gamut). The ideal subtractive primaries have now been shown to be cyan, magenta and yellow [5]. The painters' primaries of red, blue and yellow were derived partly based on the availability of pigments that could yield saturated colours [10] and have now been shown to be non-optimal in terms of the subtractive gamut. For additive mixing, however, the greatest gamut can be generated using the primaries red, green and blue and for this reason digital display devices such as televisions and LCD monitors use red, green and blue as the primaries. The additive primaries are red, green and blue and they produce in binary mixture the secondary yellow, magenta and cyan. The subtractive primaries are cyan, magenta and yellow and they produce in binary mixture red (yellow + magenta), green (yellow + cyan) and blue (magenta + cyan).

An understanding of colour management and colour physics are also important in art & design since colour management is both necessary and ubiquitous in the digital world. This study is concerned with the level of knowledge of art & design students and questions how important it is for students to be equipped with an understanding of colour theory, colour management and colour physics. It has been suggested that knowledge can shed light on aspects of colour that are confusing, it can help designers to avoid mistakes, and it can reveal a range of new possibilities [11]. How valid is this statement? A study of colour knowledge in students undertaking design education at the University of Leeds in the School of Design was undertaken to address this question. Some preliminary findings from that study are presented in this paper.

2. METHOD: A web-based questionnaire was constructed and students enrolled on undergraduate and postgraduate programs in the School of Design at the University of Leeds were invited to take part. Approximately 800 students received invitations and about 10% of these took part in the survey leading to 73 responses. The students were at various stages of completing their programmes. The survey consisted of 13 questions and participants responded on screen and then submitted their responses which were then automatically collected and analyzed. Two questions determined the particular programme of study that the student was engaged with. Four questions related to digital knowledge and knowledge of colour mixing/primaries (see Figure 1). Seven questions probed how students engaged with colour management and whether they were satisfied with the colour-related design software/hardware in the School.

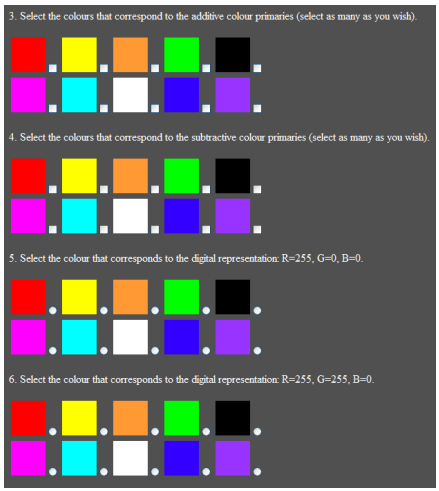

Figure 1: Screen shot of the four questions that test colour knowledge.

3. RESULTS: Figures 2-5 show the results of the questions about colour primaries and digital colour representations (see Figure 1). When asked to identify the three additive primaries, 55% of students could successfully identify red, green and blue (Figure 2). By contrast, only 29% could identify cyan, magenta and yellow as the subtractive primaries (Figure 3). Of those (52) who could not identify the optimum subtractive primaries, 10 named red, yellow and blue (which are, of course, the artists' or painters' primaries. It seems reasonable to accept either CMY or RYB as correct answers for the subtractive primaries; however, this would still only yield 42% correct answers. It is, perhaps, a little surprising that students seem more familiar with additive mixing than with subtractive mixing, even accounting for the confusion between CMY and RYB. However, 80% of students were aware that there were three additive primaries.

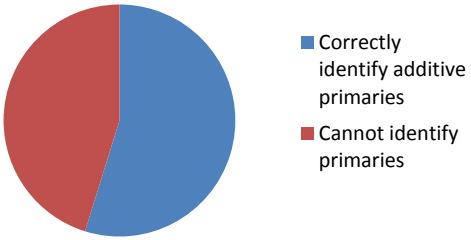

Figure 2: Additive Mixing

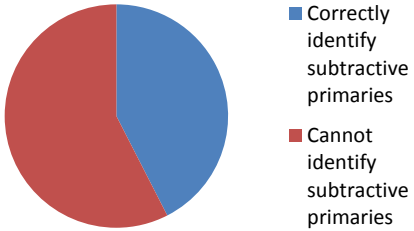

Figure 3: Subtractive Mixing

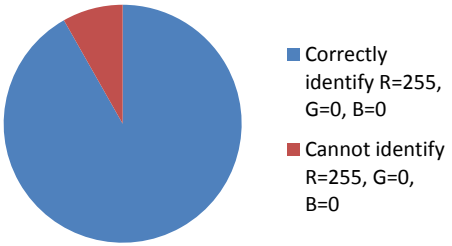

Figure 4: R=255, G = 0, B = 0

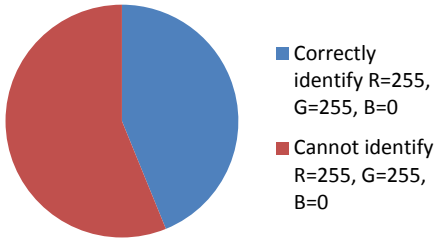

Figure 5: R = 255, G = 255, B = 0

Figures 4 and 5 show the proportion of students that were able to identify R=255, G = 0, B = 0 as red (92%) and R=255, G = 255, B = 0 as yellow (44%). That 92% of students understand that R=255, G = 0, B = 0 corresponds to red indicates that they were familiar with the notation and concept of RGB representation; yet, less than half were able to correctly predict the additive mixture of red and green. This is consistent with some related studies [12]. Figure 6 shows the responses to the question of how important are colour to design? Approximately 95% of students believe that colour is critical or very important to design.

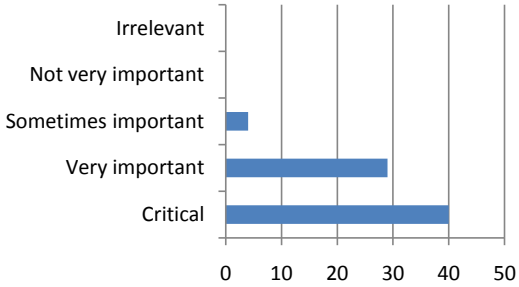

Figure 2: Number of respondents on the importance of colour to design

4. CONCLUSIONS: This study was concerned with the level and requirement for colour knowledge in design education. The study revealed that about half of students were able to identify the additive and subtractive primaries (though knowledge of additive colour mixing was surprisingly greater than for subtractive colour mixing). The survey also indicated that students' understanding of digital (RGB) colour representation was limited. Despite this, 95% of students responded that colour is critical or very important in design.

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