An experimentation on children's colour preferences in generic terms and applied to a school context

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ABSTRACT

The aim of the paper is to present an ongoing study on the evaluation of children's colour preferences in the school context. In particular, two experiments have been planned and partially conducted in order to evaluate both the differences that may be found between colour preferences expressed in generic terms and contextualized in a school environment, and the differences that may be found between digital simulations displayed on the computer and experimented using the CAVE technology. The paper presents the methods of the two experiments and the results of the first experimentation conducted on children between the ages of 6 and 10 using an online questionnaire that showed children both digital colour samples and digital colour simulations of the same colours applied to a classroom environment.

1. Introduction

Several authors have highlighted the importance of colour in school environments in relation to both functional and emotional values, also offering indications regarding the colours and schemes to be adopted (Birren 1969, Mankhe 1998, Grube 2014, Engelbrecht, 2003). In the framework of the studies about the evaluation of the emotional response to colour in children, and therefore on children's colour preferences and associations, some experiments were conducted by circumscribing these evaluations to specific contexts. In these studies, simulations of differently coloured interior environments are subjected to the evaluation of children instead of generic or abstract colour samples. In particular, the studies by Read and Upington (2009) and Dalirnaghadeh (2016) assessed children's colour associations and preferences in preschool interiors using the image of a school environment manipulated to create different colour alternatives. In the study by Park (2014), the correlations between colour attributes and children's colour preferences for interior room colours were analysed using scale-models. These studies contribute to the discussion regarding the role of the context in which the emotional response to colour is evaluated and therefore the possible design implications related to the study of colour preferences and associations in children. On the other hand, the limits linked to the simulation of reality and its simplification, even in monochromatic terms, raise the need for more circumstantial studies and research to concretely guide the design choices (Boeri, 2019).

In this framework two experiments have been planned and partially conducted in order to evaluate both the differences that may be found between the colour preferences expressed in generic terms and contextualized in a school environment, and the differences that may be found between digital simulations displayed on the computer and experimented using the CAVE technology.

2. Methods

The study focused on the design of two experiments for the evaluation of children's colour preferences in a general and contextualised situations using digital simulations of a primary classroom environment. Both the experiments were designed to involve children (age 6-10) in the evaluation of a selection of 26 colours firstly showed just as digital colour samples and then applied to digital simulations of the same classroom using a 3D model to be experienced in monitor for the first experimentation and in a CAVE for the second one.

CAVE technology will allow the display of a 360 ° image of the classroom created as a 3D model.

The model used for the simulation consist in a traditional classroom of 25 children set up with desks, chairs, wardrobe and shelves. The furnishings used have a gray-coloured metal structure and natural coloured beech wood seats, backrests and shelves (*Figure 1*).

Fig. 1. The classroom view used in the study.

Different colours were applied exclusively to the walls in a monochromatic solution of the classroom environment, which means all the walls were coloured with the same colour. This solution has been used in several studies both to verify the psycho-physiological effects of single colours (Hettiarachchi and Nayanathara 2017; Kwallek et al. 1996; Kwallek and Lewis 1990), and to probe colour preferences related to a specific environment (Read and Upington, 2009; Dalirnaghadeh, 2016).

The colours selected were decided on the base of their recurrence in the literature addressing the children's colour preferences taking into consideration the belonging to the same age group (6-10 years), and the adoption of material coloured sample for the methodology of investigation (Child et al., 1968; Boyatzis and Varghese, 1994; Terwogt and Hoeksma, 1995; Hettiarachchi and Nayanathara, 2017). These colours are: Red, Blue, Green, Yellow, Purple, Pink, Orange, and as achromatic colours White, Black and Gray. As specific colour notations relating to the colour samples adopted in the previous studies considered were not always available, the selection of the samples was carried out using NCS - Natural Colour System. The chromatic colours, except pink, were chosen with maximum chromaticness, i.e. the sample closest to the apex of the NCS colour triangle. In addition, for each hue two additional samples were selected in order to obtain a lighter and darker colours option. Even for the Gray colour two more samples were selected with different blackness.

Thus, the total number of samples selected for the study was 26 (*Figure 2*).

Fig. 2. The 26 NCS standard colours identified for the experimentations. At the top the high chromaticness colours followed by the lighter and darker colour options.

Once the colours were identified, the walls of the classroom image were modified using Photoshop software, in order to obtain one classroom chromatic configuration for each colour, and then 26 different colour configurations of the same classroom to be evaluated.

3.1. Experimentation I

The first experimentation aimed to collect and evaluate preliminary data on abstract and contextualized children's colour preferences using digital colour samples and digital colour simulations of classroom environments to be compared with each other and with the reference studies.

The experimentation consisted in the administration of an online questionnaire to school-age children, between the ages of 6 and 10, of both sexes. The questionnaire was designed to be easy for the child to understand and to fill out quickly. One of the main advantages of using the online questionnaire is the ease in reaching a large number of subjects in a short time. On the other hand, the supervision of children delegated only to parents and not done by an expert, may either not be sufficient, or on the contrary, be too intrusive, affecting the children's responses (Punch, 2002).

The questionnaire was divided into two main macro sections, and preceded by the request to complete some general information about the children age and gender.

The first section of the questionnaire focused on the investigation of abstract colour preferences. In the first question children were asked to specify the preferred colour among those shown: Yellow, Orange, Red, Purple,

Blue, Green, Pink, White, Black and Gray. The options to choose from for this question are presented all together, but in a random order, automatically generated by the Google form. The participant was given the opportunity to provide only one answer to the question. Despite the awareness that colours displayed on unknown and different devices would be different from those identified in the preliminary phase, the form presented visual reference of all colour samples, together with a corresponding colour name, to create a subsequent comparison with the same colour applied in the classroom environment. In the second question of this section, children were asked to assign a grade for each colour (from 1 to 4, where 1 is the lowest and 4 the highest), in order to create a ranking of preference. This method allows to gather more information on the same subject regarding not only the preferred colour, but also to all the other samples (Guilfort and Smith, 1959). In the third question children were asked to further express their preference on the colour they already chosen as the favourite in comparison with two more samples of the same hue and different blackness and chromaticness that would appear lighter and darker.

The second section of the questionnaire was about colour preferences applied to classroom images. The structure of this section was the same as the previous one. Children were asked firstly to choose their preferred coloured classroom among those shown, then to assignee a grade for each coloured classroom image (from 1 to 4), and finally automatically directed to the question that involved the coloured classroom they already chosen as the favourite in comparison with two more variants that would appear lighter and darker.

The period in which data were collected was from April 2020 to May 2020. Thanks to the collaboration of the teachers, the answers were given by children attending five different primary schools of Lombardia region in Italy. Specifically, the number of children who participated in this experiment was 101, of which 53 were females and 48 were males. The children's average age participating in the survey was 8.5 years.

3.2. Experimentation II

The second experimentation, not yet conducted, involves the use of CAVE technology to simulate both abstract colours and the context of colour preferences. The colours and the 3D representation of the classroom used in this experimentation are the same as those illustrated previously for the first experimentation (*Figure 3*).

The CAVE (Automatic Virtual Environment) of the ED-ME LAB - Laboratory for environmental design and multisensory experiences, of the Politecnico di Milano, is used for the experimentation. The simulation of this CAVE

is semi-immersive, through the use of three synchronized projection screens. The projected images are not stereoscopic. The screens on which the image is projected are touch and therefore allow an interaction between the image and the viewer in the CAVE. Furthermore, it is also possible to reproduce sounds and interact vocally with the CAVE system.

The structure of the questions addressed to children is the same as the first experimentation. The differences are in the physical presence of the children participating in the trial and in the smaller number of children involved. The results obtained from this second experimentation will be compared with those of the first experimentation in order to evaluate the different degrees of control over the accuracy in digital colour reproduction as well as to estimate the effects of children's involvement.

Fig. 3. The CAVE (Automatic Virtual Environment) of the ED-ME LAB, Politecnico di Milano, used for the experimentation.

4. Results

The results of the first experimentation allow us both to understand if the colour preferences expressed by children in abstract terms using digital colour simulations are consistent with the results of the reference literature, and to understand if the preferences for the abstract colour are consistent with those expressed for the digital simulation of the class.

With regard to colour preferences expressed in generic terms, the answers to the questionnaires were analysed both as a whole and on the basis of the age and gender of the participants. The most preferred colour was Blue. This result appears consistent with Child et al. (1968) and Terwogt and Hoeksma (1995). The colours with the lowest preference scores were Orange, Black and Gray,

that was also found in Boyatzis and Varghese (1994) and Hettiarachchi and Nayanathara (2017). No child has

chosen White as their favourite colour. The percentages of preferences attributed to each colour with respect to the entire sample of children (101) were: Blue 20.8; Red 17.8; Purple 13.9; Yellow 13.9; Pink 10.9; Green 9.9; Black 5.9; Orange 5.9; Gray 1.

The analysis of the responses on the basis of the number of females and males who participated in the experimentation (53 females and 48 males) showed, as already emerged in other studies (Ellis and Ficek, 2001; Hurlbert and Ling, 2007), a gender difference in colour preferences (*Figure 4*). The preferred colour for females was Purple, while for males Blue, as it was found in Boyatzis and Varghese (1994).
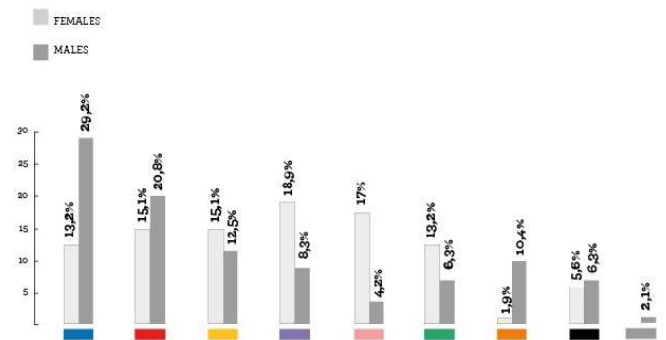

Fig. 4. Abstract colour preferences referring to the number of females and males who participated in the experiment (53 females and 48 males).

The analysis of the responses on the basis of the children's age who participated in the experiment, highlighted, as already emerged in other studies (Garth and Porter, 1934; Boyatzis and Varghese, 1994; Terwogt and Hoeksma, 1995; Zentner, 2001) a greater number of preferences for warm colours in children of 6-7 years compared to other age groups where more marked preferences for cold colours emerged.

The preliminary results of this first part of the experiment, aimed at evaluating colour preferences in generic terms using digital colour visualizations, show consistencies with respect to the studies taken into consideration that used material colour samples (Child et al., 1968; Boyatzis and Varghese, 1994; Terwogt and Hoeksma, 1995; Hettiarachchi and Nayanathara, 2017).

Moreover, the results of the first experiment allow us to understand whether the colour preferences expressed by children in general have been confirmed or not once applied to the classroom context. The percentage of children who expressed a different colour preference in

relation to the differently coloured classroom displays was 54 percent (of which 58% were males and 52% were females).

Comparing the preferences given for each colour in the two situations (abstract and applied to the class image) in relation to gender (*Figure 5*), we can observe an increase in preference for Pink in males and an increase in preference for Blue in females. Furthermore, White appears more appreciated in both males and females when contextualised. Even preferences for Black are increased when contextualised compared to preferences for the abstract colour.
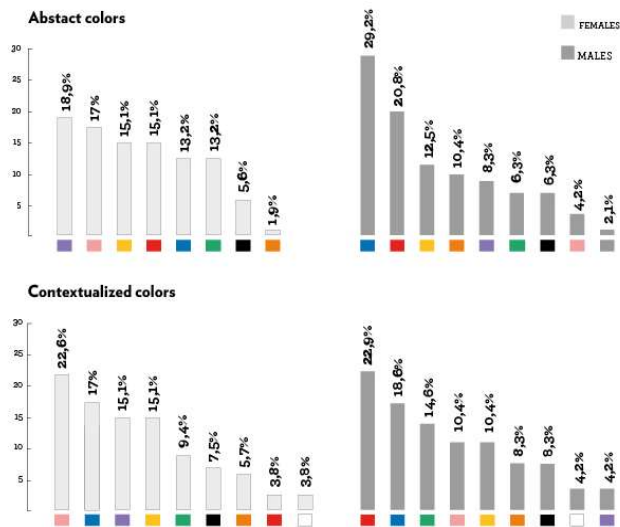
Fig. 5. Preferred abstract and contextualised colours for females and males.

A further comparison with respect to the lightness parameter given for each colour (*Figure 6*), shows how in the contextualized situation there is an increase in appreciation for the lighter variation of the colour chosen as the favourite.

Therefore, we can say that preferences for the contextualized colours appear both different and more diversified compared to abstract colour preferences.
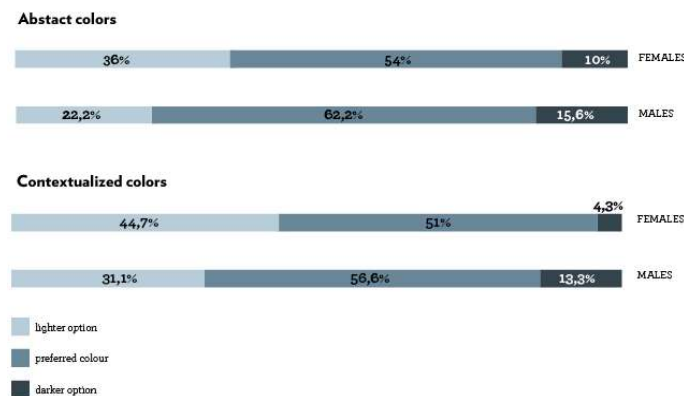

Fig. 6. Preferred abstract and contextualised light-dark options of the favourite colour for females and males.

5. Conclusion

The aim of the study is the evaluation of children's colour preferences in general and contextualised situations using digital simulations. The two experiments had the common purpose of probing the children's colour preferences, both abstract and contextualized, and to identify any differences among the two.

Although it is clear the difference between the digital simulation of an environment and the experience of a real environment, there are many advantages offered by the possibility of using the digital simulation to understand if and how the colour preferences in children can be affected by the contextualization in specific and different contexts. Therefore, this study aims to use digital simulation with varying degrees of control over accuracy in colour reproduction as well as varying degrees of realistic feeling of environment and children's involvement, in order to contribute to explore the design implications of colour preferences and associations.

6. Conflict of interest declaration

The authors declare no conflict of interest related to this publication.

7. Funding source declaration

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9. Short biography of the authors

Cristina Boeri - Architect, PhD, she deals with the perceptual and design aspects of color, combining design, research and educational activities. Since 2001 she has been carrying out and coordinating teaching and research activities at the Color Laboratory, Department of Design, Politecnico di Milano. Since 2013 she has been adjunct professor of Color and perception at the School of Design, Politecnico di Milano. She is co-founders and current president of the Color Placemaking Association.

Camilla Giani - Graduated in Interior and Spatial design at the Politecnico di Milano in 2020 with a master's thesis *The experimentation of children's colour preferences in a school context* under the supervision of professors Mario Bisson and Cristina Boeri. Since 2020 she has collaborated with the Color Laboratory of the Politecnico di Milano for the development and advancement of her work started with her thesis.

Licensing terms

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