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UNIVERSAL DESIGN FOR LEARNING: THE APPLICATION OF THE COLOR BLIND ALPHABET

DESIGN UNIVERSAL PARA APRENDIZAGEM: A APLICAÇÃO DO ALFABETO CEGO DE COR

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Abstract: Universal Design for Learning stands at the forefront of educational policy to create universal access to educational curricula for all students, including students with special needs. The ColorADD system is a universal language, describing the three main colors, blue, yellow and red with simple graphic symbols, which, through coding and addition combinations, can associate and record the entire color palette. The ColorADD recognition system developed by Dr. Miguel Neiva. The application of a color code alphabet in very essential. It can be used in many sectors, such as music education, and will concern education and educational integration policy, but also the global community with various applications for various aspects of human activities.

Keywords: Universal Design. Special needs. Color blind alphabet. ColorADD.

Resumo: O Design Universal para a Aprendizagem está na vanguarda da política educacional para criar acesso universal aos currículos educacionais para todos os alunos, incluindo alunos com necessidades especiais. O sistema ColorADD é uma linguagem universal, descrevendo as três cores principais, azul, amarelo e vermelho com símbolos gráficos simples, que, por meio de combinações de codificação e adição, podem associar e registrar toda a paleta de cores. O sistema de reconhecimento ColorADD desenvolvido pelo Dr. Miguel Neiva. A aplicação de um código de cores do alfabeto é muito essencial. Pode ser usado em muitos setores, como a educação musical, e diz respeito à educação e à política de integração educacional, mas também à comunidade global, com várias aplicações para vários aspectos das atividades humanas.

Palavras-chave: Design universal. Necessidades especiais. Alfabeto daltônico. ColorADD

I. Introduction

Universal Design for Learning (UDL) aquires the potential to increase accessibility and transformation of the learning process (Rose & Meyer, 2006). According to Soulis (2013), Universal Design in education is reflected in numerous practices, such as the use of digital media and new technologies, so that students with special needs can access knowledge through a wide range of different ways of learning. UDL has the efforts to create universal access to educational curricula for all students, including those with disabilities (King-Sears, 2009; Rose, 2000).

Color blindness is an extremely important factor related to common vision problems, but without the apropriate consideration, and it concerns current research and will affect educational policy and the modern learning environment (Matar et al., 2019; Marey et al., 2014; Cole et al., 2005). It is estimated that 350 million people, about 10% of the male population, that is, one in twelve males and 0.5% of the female population and one in two hundred females belong to the group of people with color blindness problems (Colour blindness, 2021).

Color blindness, Color Vision Deficiency (CVD) or Dyschromacy is a disorder of color perception, which was originally defined in research as color blindness - Color Blindness (Hunt et al., 1995). It can be hereditary, which means that the patient is born with difficulty in perceiving colors or acquired when the normal function of the optic nerve is impaired. Dyschromatosis affects many aspects of daily life (Steward & Cole, 1989). Any person with color blindness can distinguish colors, e.g. green and red or blue and yellow.

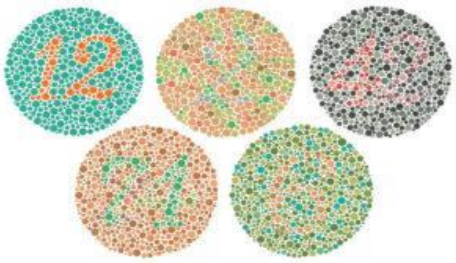
Color blindness can be complete when all colors are affected, or partial as color blindness when certain colors are affected. The first is extremely rare and is usually accompanied by other ocular abnormalities. Partial color blindness, red-green, is the most common form, while rarer or less common is the inability to perceive the blue-yellow color.

The symptoms are usually noticed by the parents when the child cannot see or distinguish a color. The diagnosis of color blindness is made by the clinical ophthalmologist during the examination, usually in preschool age, through the special color perception tables Ishihara charts, invented by the world-famous Japanese ophthalmologist Dr. Shinobu Ishihara (Marey et al., 2014; Arnaoutoglou, 2011).

These tables depict shapes or numbers formed within a patchwork of colored spots that allow vision problems to be detected and help control the degree of color blindness, as in Figure 1 (Ishihara Test, 2020; Kulshrestha & Bairwa, 2013).

Figure 1

Ishihara color vision test plates



Source. Ishihara Test. (2020, March 5). https://www.webeyeclinic.com/color-blind/ishihara-test

II. Types of Color Blindness

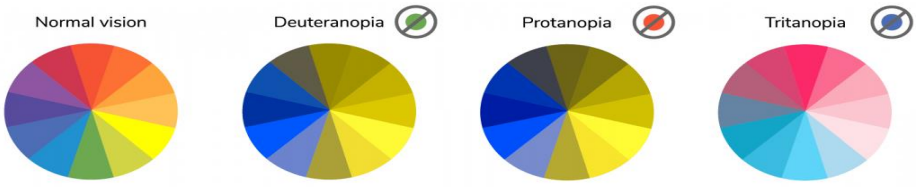
Based on this knowledge about our visual system, different forms of discoloration are recorded that are directly related to the three types of cones located in the back of the eye, in the retina, and function as photoreceptors. Normally there are three types of cones called S-cones, M-cones, and L-cones as sensitive photoreceptors for blue, green and red respectively, despite the plethora of colors we see (Kulshrestha & Bairwa, 2013). Different forms of discoloration are detected by diagnostic tests:

- Monochromacy: There are no cones or just one type of them.
- Dichromacy: With proper operation of two different types of cones and the absence of the third
- Anomalous Trichromacy: There are all three types of cones, but they malfunction, resulting in the recognition of a smaller range of colors.

Dichromacy and Anomalous Trichromacy are divided into three subtypes of dysfunction, as shown in Figure 2:

Figure 2

Deuteranopia, protanopia and tritanopia test tables



Source. Sydney Eye Hospital Foundation. (n.d.). *The best test for colour blindness* https://sydneyeyehospitalfoundation.org.au/the-best-test-for-colour-blindness/

- Protanopia: There are no cones or just one type of them.
- Deuteranopia: With proper operation of two different types of cones and the absence of the third
- Tritanopia: There are all three types of cones, but they malfunction, resulting in the recognition of a smaller range of colors.

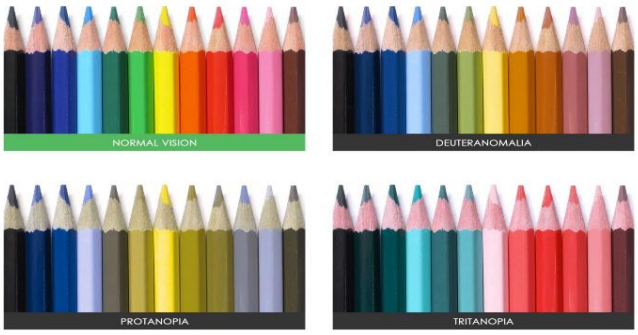
People with protanopia have difficulty distinguishing black from different shades of red, deep brown from deep green, dark orange from dark red, shades of blue from those of red and purple, shades of green from orange.

People with deuteranopia can not distinguish shades of red from green, light green from yellow, green-blue from shades of gray and light pink from light gray, light blue from lilac.

In tritanopia dysfunction, which is a rarer form of color blindness, people find it difficult to distinguish deep purple from black, shades of orange from red, blue from gray, and shades of green from shades of blue. In the most severe form of achromatopsia, which is rare, the patient sees in shades of gray, and usually shows a decrease in vision, as well as rapid eye movements-nystagmus. Figure 3 distinguish these above categories.

Figure 3

Ways of vision in cases of protanopia, deuteranopia and tritanopia



Source. Batagoda, M. (2018, Dec. 26). *Most common color in design.* https://uxplanet.org/most-common-color-in-design-ef14bb1ee1b1

Achromatopsia is incurable. In recent years, the auxiliary use of special color filters that can improve color perception has been investigated (Martínez-Domingo et al., 2019). If a student has problems with color blindness, an early diagnosis is vital and the school must be informed. A large number of activities in the learning environment, especially in early school age, are based on colors. Late treatment of vision problems related to color blindness can have serious consequences for the social development of students.

In addition, the problems of color blindness must be taken into account for career guidance. It is therefore necessary to provide accessibility solutions to the educational material and in the educational environment in general for students with color blindness problems.

III. The ColorADD aphabet code

In recent years, a significant effort has been made to integrate a special color code into education, sports and many aspects of daily life. Using a special code alphabet, such as the ColorADD and Feelipa Color Code systems, developed in Portugal, achieves equal management and accessibility for students with color blindness problems (Iamaguti et al., 2018; Neiva & Guedes, 2009).

ColorADD (www.colorADD.net) is a color recognition system developed by Miguel Neiva, with the motto "Not everyone sees colors the same way", which was awarded the Gold Medal in Portugal during the celebration of fifty years since the Universal Declaration of Human

Rights and a series of international distinctions of innovation. ColorADD is an innovation tool that ensures the full integration of students and the visually impaired in color distinction.

The ColorADD system is a universal language, describing the three main colors, blue, yellow and red with simple graphic symbols, which, through coding and addition combinations, can associate and record the entire color palette as shown in Figure 4 (Neiva & Guedes, 2009).

Figure 4

The basic colour alphabet ColorADD

Source. Neiva, M. Code ColorADD. http://www.coloradd.net/code.asp

Three simple symbols represent the basic colors: blue (cyan), yellow, red (magenta). This color code can be easily memorized and applied to everyday life. It is noteworthy that the color coding alphabet, in addition to educational benefits, catalyzes the development of social skills, the creation and development of a collaborative environment, sports activities and in general the full integration of people with color discrimination problems.

Universal Design accessibility in color, opens the gates to a wide range of actions, such as application to pedestrian crossings, in metro maps, in children's books, in geometric shapes and diagrams, in images and stationery, pencils, markers, etc. , as shown in Figure 5 (Neiva, 2017).

Figure 5

Pencils using color code alphabet ColorADD

Source. Color Identification System. (n.d). Universal & transversal. http://www.coloradd.net/education.asp

To date, the color code has been applied in more than fifteen 15 countries, in public transport, subways, airports, gathering places, museums, shops, tourist guides, in the clothing industry, in the automotive industry, in products where color is a point of reference, in sports facilities, children's games, recreation areas, the pharmaceutical industry and it is increasingly established (Kevin et al., 2020; Neiva, 2017).

The leading toy company MATTEL with the application of the code in the game UNO adapted it as UNO colorADD (Mattel Games, n.d.), while other educational applications are being prepared. Application and adaptation can be made easily, for example online maps with subway lines, as typically depicted on the Seoul subway map (Neiva & Guedes, 2009).

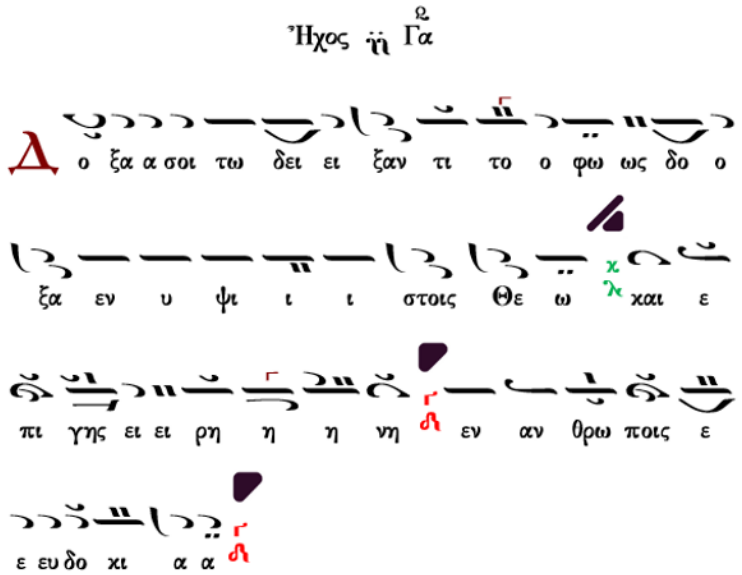
In Greece and in the Southeastern Mediterranean, the development of the colorADD code is being implemented with the Noriaki Kano Laboratories, the sports laboratory of the School of Physical Education and Sports Science at the National and Kapodistrian University of Athens and in the Holy Diocese of Nea Krini and Kalamaria in Thessaloniki which has made a remarkable effort to create conditions for an inclusive approach, especially in its cultural and educational work for students with color blindness problems.

The collaboration began in February 2021 through a Protocol signed by His Eminence Metropolitan Iustinos, the Metropolitan of Neas Krinis & Kalamarias and the ColorADD Organization, giving the seal of approval to the teaching of chanting at the School of Byzantine Music, which operates at the "Prokopio" Multipurpose Ecclesiastical Educational Center, at the Byzantine chant music school,and for the people who take part in the Summer Camp. Additionally, a pilot application is being prepared in digital books with content on functional issues, such as the color diversity of sacred vestments, etc.

In music education the ColorADD code can be used for the visual marking of points or other music symbols in the byzantin music chant notation that have a different color marking so that the musical text is fully accessible to students with color blindness as shown in Figure 6.

Figure 6

The use of the Color code alphabet ColorADD in Byzantine chant notation



Note. The green and red 'martyrias' symbols indicate the pitch that the Byzantine chanter should be on according to the scale. In the example the green and red 'martyrias' symbols are shown with a different color. The ColorADD code is provided above the music notation.

IV. Conclusion

Universal Design-Learning, in the field of education, focuses on creating a learning environment, without barriers, easily accessible and user-friendly for any student with or without educational needs. The application of a color code alphabet could be very essential for students with dyschromacy. ColorADD make figures and presentations that are friendly to colorblind people. It can be used in many sectors. In general, the application of the color code alphabet,

will concern education and educational integration policy, but also the global community with various applications for different aspects of human activities and the economy.

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