The Inclusive Classroom: The Effects of Color on Learning and Behavior

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Color impacts student behavior within the physical learning environment. Due to the move toward including students with disabilities in the general education classroom, functional color applications are critical. This article reviews and analyzes existing literature and empirical evidence related to use of color in the classroom for students of all abilities. The three major areas reviewed were (1) the inclusive classroom for students with disabilities, (2) color theory, and (3) the physiological and psychological aspects of color. The results show that color is important in designing functional learning spaces. The results of this analysis may benefit educators, parents, and design professionals in designing beneficial learning environments for all students.

Color is a powerful design element that produces profound psychological and physiological reactions. Studies have shown a relationship between color preferences, emotions, and academic performance in students (Boyatzis & Varghese, 1993; Imhof, 2004; Karp & Karp, 2001; O'Connor, Sofo, Kendall, & Olson, 1990; Terwogt & Hoeksma, 2001; Wilkins, 2003). The inclusion of learners with disabilities in the general education classroom creates additional challenges for learning and behavior.

Federal law requires that children be educated in the least restrictive environment (LRE). The LRE is the requirement that special education students be educated with children without disabilities in the regular educational environment to the maximum extent appropriate to serve their needs. The Individuals with Disabilities Education Act (IDEA) of 2004 addresses the legal rights of students with disabilities.

Some students (such as those with Attention Deficit/Hyperactivity Disorder and Autism Spectrum Disorders) may be more sensitive to color in the learning environment due to heightened sensory responses and strong visual processing abilities (Freed & Parsons, 1997).

In the United States, every general education classroom is potentially inclusive. Teachers and school administrators need to understand the ways that color affects student behavior. A thoughtfully planned physical environment will enhance the psychological comfort of the most sensitive students by identifying and eliminating detrimental sensory impact. Careful planning during construction, selection of materials and finishes, and spatial organization can play a major role in behavior and learning in the classroom. The impact of the built environment on individuals with autism is a complex issue that has not been studied. Therefore, information must be gleaned from many areas to form conclusions. The purpose of this paper is to identify the impact of color on student behavior and achievement and make recommendations for appropriate use.

Method

An initial literature review was conducted using keywords to define interrelated categories. This method assisted in the identification of more specific keywords that related to

inclusion, color theory, and physiological and psychological reactions to color. The keywords were physical learning environment, color, learning disabilities, autism, attention deficit disorder, inclusion, integrated classroom, exceptional children, and special education.

The databases used were Pubmed, EBSCO Host, Google Scholar, Medline, PsycInfo, PsycArticles, Psychology and Behavioral Sciences Collection, Education Research Complete, Health Source, and Texas Tech University Libraries. Potential studies were identified from the review of articles and books. The studies were included if they were written in English and provided empirical validation on the impact of color in the classroom, the effects of color on mood and behavior, the effects of color on individuals with disabilities, or psychological and physiological responses to color.

Although a number of issues were discovered about color and students with disabilities, only pertinent findings relating to color application in classroom settings were included. Additionally, potential articles and books were identified by a systematic review of literature into the four categories of inclusion, color theory, physiological reactions to color, and psychological reactions to color. Finally, the reference lists for the included articles were inspected. Five books and eleven refereed articles were identified as meeting the criteria.

Literature Review

The Inclusive Classroom

Inclusion is a controversial concept in education whereby each student is integrated to the fullest extent possible in a general education classroom (Burke & Sutherland, 2004). The support services may be brought to the child instead of moving the child for services. Proponents of inclusion believe that the student should begin in general education classrooms and should only be removed if the necessary interventions cannot be provided in a regular classroom (Baker, Wang, & Walberg, 1995; Banerji & Dailey, 1995; Rea, McLaughlin, & Walther-Thomas, 2002). Those opposed believe that many students with disabilities are better served in special education classrooms or that inclusive classrooms provide no benefit (Fore, Hagan-Burke, Burke, Boon, & Smith, 2008; Holloway, 2001; McDonnell et al., 2003).

The Individuals with Disabilities Education Act (IDEA) enables millions of children with disabilities to receive special services designed to meet their unique needs. Children and youth between the ages of three and twenty-one may be eligible for services under thirteen different disability categories. The categories include autism, deaf-blindness, emotional disturbance, hearing impairment (including deafness), mental retardation, multiple disabilities, orthopedic impairment, other health impairment, specific learning disability, speech or language impairment, traumatic brain injury, or visual impairment (National Dissemination Center for Children with Disabilities, 2009).

In a July, 2007 report by the U.S. Department of Education, Office of Special Education Programs, 6,693,279 children with disabilities (ages 3-21) received special education under the Individuals with Disabilities Education Act. Full inclusion is not required by law and is not beneficial for all students with learning differences. A continuum of placements should be made available from full inclusion to self-contained special education classroom. According to the report (U.S. Department of Education, 2007), seventy-seven percent of students with disabilities spent at least forty percent of their day in general education classrooms. Over fifty-three percent spent at least eighty percent of the day in general education classrooms. The estimated 2.5 million children with Attention Deficit/Attention Deficit Hyperactivity Disorder (ADD/ADHD) are not served under IDEA and are not included in the statistics.

Great challenges may come with the inclusion of students with disabilities in general education classrooms. The physical learning environment must meet the needs of all students as the special and regular education systems merge. Color within the physical learning environment must be considered because of its profound effect on learning and behavior.

Color Perception and Theory

A brief explanation of color perception and theory are necessary to formulate a better understanding of the physiological and psychological responses to color. Color originates in sunlight and is perceived through subtractive color theory. The various wavelengths of light shine on an object and the surface absorbs or subtracts all the colored light rays except for the ones reflected from the object. This color is reflected received through the cells of retinal wall of the eye (Morton, 1995). Visible colors are defined by the cones of the eye. Humans have three kinds of cones: red, blue and green. These three wavelengths decipher millions of colors. Approximately 2-3 percent of women and some animals have at least four types of cones which increase color differentiation (Morton, 1995). These receptor cells absorb the hues and send a message to the brain where the colors are deciphered. Brain impulses are also sent to the major endocrine regulating glands that cause emotional and psychological responses (Nielson & Taylor, 2007). These receptors constitute two distinct pathways; a red-green system and a blue-yellow system (Banaschewski et al., 2006).

The Standard Color-Wheel theory (Morton, 1995) is based on a conventional color wheel. Red, yellow, and blue are primary colors meaning that they cannot be mixed by the combination of other colors. Secondary colors are formed by mixing the primary colors and tertiary colors emerge from mixing the secondary colors. These twelve colors compose the conventional color wheel. An unlimited number of colors may be obtained by mixing the twelve colors of the wheel along with black and white.

Color has three basic attributes: hue, value, and saturation (Morton, 1995). Hue is another word for color such as blue, red, or yellow. Value is the relative lightness or darkness of a color. A hue may be lightened by adding white or darkened by adding black. Intensity (also saturation or chroma) is the purity of a hue. A decrease in purity causes the hue to be muted or dull (Morton, 1995).

Color is also classified according to temperature. Half of the color wheel is classified as warm and the other half as cool. Colors associated with red and yellow are considered warm. Warm colors advance in a space. Cool colors are associated with blue and tend to recede. Visual temperature may also be affected by intensity (Nielson & Taylor, 2007). Overall, preschool and elementary age children prefer warm colors, and secondary students prefer cool colors (Engelbrecht, 2003).

Color perception and temperature are also influenced by lighting. Placing a blue painting under a bluish light (such as a cool fluorescent) will heighten the blueness of the painting. However, a red painting under a blue light will become dull and grayish because no red color waves are being made by the light. A study by Styne (1990) showed that a space painted with cool colors under cool fluorescent lighting resulted in spaces that seemed larger, quieter, and cooler. A space with warm colors under warm incandescent lighting resulted in a more active space that seemed smaller, warmer, and louder. Fast food restaurants use warm bright colors to stimulate appetite and the perception of noise. As a result, sales increase due to the fast turnover. Such information provides useful insight when designing environments beneficial for learning.

A study conducted in Germany (Banaschewski et al., 2006) determined that students with ADHD experienced distorted color discrimination abilities. This distortion occurred along the blue-yellow system. No distortion was found involving the red-green pathways. The blue-yellow color vision problems were also found with Tourette's syndrome, Parkinson's disease, Huntington's disease, cocaine-withdrawal, normal aging, and exposure to environmental pollutants (as cited in Banaschewski et al., 2006). Based on the review of literature, this is the first and only study of color perception in students with ADHD. The implications of these findings are unknown through empirical evidence; however, conclusions have been drawn on the physiological and psychological reactions to color in the general population. This color vision impairment warrants further investigation in individuals with color distortion to determine if the reactions are the same or different.

Physiological and Psychological Responses to Color

Responses to color are both scientific (physiological) and emotional (psychological). Studies (Engelbrecht, 2003; Morton, 1998) related to physiological effects have shown changes in blood pressure, eye strain, and brain development. For example, exposure to red causes the heart to beat faster, an increase in blood pressure, and a heightened sense of smell. In contrast, blue causes a slower pulse rate, lower body temperature, and reduced appetite (Engelbrecht, 2003).

Psychological responses to color include changes in mood and attention (Engelbrecht 2003; Shabha, 2006). The brain releases a hormone which affects moods, mental clarity, and energy level when color is transmitted through the eyes (Engelbrecht, 2003). For example, pink may suppress aggressive behavior in prisoners (Walker, 1991). Interestingly, color's impact is not limited to visual aspects since color wavelengths are absorbed by the skin (Torice & Logrippo, 1989). Wohlforth and Sam (1982) also supported this claim in their study. Findings showed that changes in the color of the environment resulted in a drop in blood pressure and reduction in aggressive behavior in blind children as well as sighted.

Some color responses are temporary and others may last for a long period of time. Many reactions are immediate (Morton, 1998). A number of studies have explored the impact of color in the classroom (Engelbrecht, 2003; Grangaard, 1995; Imhof, 2004; O'Connor et al., 1990; Wilkins, 2003). Findings are inconsistent in determining the optimal color choices in learning environments. Therefore, the following information serves to provide functional guidelines and explain the importance of color in the classroom.

The research conducted by Torice and Logrippo (1989) has shown that active children prefer cool colors and passive children are more comfortable surrounded by warm colors. Morton, 1995 contend that the purity and contrast with other colors is more important than color temperature. In other words, a strong green may stimulate an individual as much as a strong red (Morton, 1998).

Additionally, quantity of color should be considered in the design of the physical learning environment. Large amounts of color overstimulate individuals no matter the color temperature or preference. Verghese (2001) discusses the process of visual search and attention in regard to signal detection theory. This theory states that the human mind continuously strives to organize visual information. Too much color, motion, or pattern functions as distracters making visual search more difficult. A stressful learning environment will result from excessive use of color. Table 1 outlines findings, issues, and associations related to specific colors.

Table 1
Categories, Issues, and Findings Related to Color

Category	Findings	Source
Red	Concerned with the base of the spine and motor skills	*Torrice & Logrippo, 1989*
	Raises blood pressure	*Morton, 1998*
	Increases respiration	
	Heart beats faster	*Engelbrecht, 2003*
	Heightened sense of smell	
	Associated with excitement and happiness	*Boyatzis & Varghese, 1993*
	Positive reaction - girls more positive than boys	
	High preference for 7-year-olds	*Terwogt, & Hoeksma 2001*
	Associated with anger, pain, happiness, and love in 4th grade students	*Karp & Karp, 2001*
Blue	Favorite color for 7 and 11-year-olds	*Terwogt, & Hoeksma 2001*
	Correlates to eyes, ears, and nose – seeing, hearing, smelling	*Torrice & Logrippo, 1989*
	Sight and hearing impaired children favor prefer blue	*Torrice & Logrippo, 1989*
	Calming effect on heart rate and respiratory system	*Engelbrecht, 2003*
	Lower body temperature	*Torrice & Logrippo, 1989*
	Reduced appetite	*Morton, 1998*
		Walker, 1991
		Morton, 1998
	Positive reaction - girls more positive than boys	*Boyatzis & Varghese, 1993*
	Associated with sadness in 4th grade students.	*Karp & Karp, 2001*
Yellow	Responds to chest, heart, lungs	*Torrice & Logrippo, 1989*
	Children with asthma and other breathing problems react favorably to yellow.	
	High preference for 7-year-olds	*Terwogt, & Hoeksma, 2001*
	Associated with honesty in 4th grade students.	*Karp & Karp, 2001*
	Most luminous and visible of all colors. Large quantities may irritate the eye	*Morton, 1998*
Green	Relates to the throat and vocal cords.	*Torrice & Logrippo, 1989*
	Affects developing speech skills.	
	The most restful for the eye.	
	Associated with life in 4th grade females.	*Karp & Karp, 2001*
Orange	Corresponds to circulation and nervous systems.	*Torrice & Logrippo, 1989*
	Tremendous tonic effect	

Category	Findings	Source
Violet	Corresponds to the top of the head and cerebral activity. Supports non-verbal activity.	*Torrice & Logrippo, 1989*
	Symbolizes high levels of wisdom and authority. In children: a mind deep in thought, concerned, or afraid.	
Pink	Positive reaction - females more positive than males	*Boyatzis & Varghese, 1993*
	Tranquilizing effect	*Morton, 1998*
	Reduces aggression in prisoners.	
Brown	Negative emotions - males more positive than females.	*Boyatzis & Varghese, 1993*
	Associated with strength in 4th grade males.	*Karp & Karp, 2001*
Black	Negative emotions - Males more positive than females.	*Boyatzis & Varghese, 1993*
	Associated with school and fear in 4th grade males.	*Karp & Karp, 2001*
Gray	Negative emotions - males more positive than females.	*Boyatzis & Varghese, 1993*
Cool Colors	Recede	*Nielson & Taylor, 2007*
	Preferred by active children	*Torrice & Logrippo, 1989*
	Recommended for secondary classrooms	*Engelbrecht, 2003*
Warm Colors	Advance	*Nielson & Taylor, 2007*
	Preferred by passive children	*Torrice & Logrippo, 1989*
	Preferred by preschool and elementary students	*Engelbrecht, 2003*

Studies by Shabha (2006) and Gaines (2008) explored the impact of visual environmental stimuli for students in a special needs and general education schools. Teachers were surveyed and determined that visual triggers (including lighting and color) in classrooms have an adverse effect on the behavior of students with disabilities. Some of the behaviors observed included staring at light sources, repetitive blinking, moving fingers in front of the eyes, and hand flapping. The outcome of these behaviors may lead to poor concentration, communication, and social interaction.

Grangaard (1995) explored the effects of color and light on learning for 6-year old students. Off-task behaviors and blood pressure were measured in two environmental conditions. The first classroom had white walls and cool-white fluorescent lights. A second classroom was modified with light blue walls and full-spectrum lights. Findings showed that off-task behaviors decreased by 22 percent in the modified room. Additionally, blood pressure readings showed a nine percent reduction in the second classroom.

There is evidence that color may impact learning outcomes of students with ADD/ADHD and ASD (Imhof, 2004; Zentall & Dwyer, 1989). Findings in the area of color preferences for learners with ASD and ADD/ADHD are varied. Some children with ASD and ADD/ADHD are attracted to bright colors, while others are overwhelmed by the stimulation. Imhof (2004), Zentall & Dwyer (1989), and Kennedy (2005) contend that color stimulation in the learning environment improves attention and motor processes, resulting in better academic performance. A study conducted by the United States Navy, showed a 28 percent drop in accidents with the introduction of color (Engelbrecht, 2003). However, white and off-white business environments resulted in a 25 percent drop in human efficiency. Monotone environments create restlessness, excessive emotional response, difficulty in concentration, and irritation (Engelbrecht, 2003).

Clay (2004), Stokes (2003), and Myler, Fantacone, and Merritt (2003) found that a subdued color scheme in warm neutral colors is necessary to prevent overstimulation. They encourage low contrast in wall and flooring. Clay (2004) found that a subdued and neutral color scheme is necessary as most children with ASD and ADD/ADHD have negative responses to primary colors. As a compromise, Engelbrecht (2003) suggests that color can relieve eyestrain by painting the wall students focus on when looking up from their work a medium hue. According to Engelbrecht (2003), the other walls should be a warm beige or tan.

A study at the University of Texas in Austin (Kwallek, Lewis, Lin-Hsiao, & Woodson, 1996) was conducted using 675 college students. Test offices were painted 9 colors (four walls and the door), including red, white, green, orange, yellow, blue, beige, gray, and purple. Students were evaluated on task performance, mood, and color preference. Findings showed gender differences in color preferences. Men preferred white, green, blue, and gray work environments and did not like yellow, orange, and purple spaces. The women preferred green, red, and beige offices and did not like the gray and orange spaces. Overall, white, blue and green offices received the highest scores. Purple and orange work environments were the least preferred.

Gender differences regarding mood in different colored environments were also observed. More depression, confusion, and anger were experienced by females in spaces with low-saturated colors of white, gray, and beige. Males experienced the negative emotions in high-saturated environments of green, blue, purple, red, yellow, and orange (Kwallek, et al., 1996). Most participants stated they prefer to work in beige or white offices. However, more errors occurred on task performance in the white office than in blue and red offices.

Additionally, studies have shown that personal applications of color can improve academic performance (Imhof, 2004; O'Connor et al., 1990; Wilkins, 2003). A study by Imhof (2004) found that students with ADHD showed improved control of attention and motor processes when using colored paper. A control group of students without ADHD did not exhibit a significant improvement when using colored paper.

The uses of colored lenses and colored overlays have shown a dramatic improvement in reading for those with reading disabilities (O'Connor et al., 1990; Wilkins, 1996). Scientific foundation for the improvement is poorly understood. Distortions in spatial perception may be manifested in letters that appear to move on the page. The use of colored lenses showed

improvement in reading and a reduction in headaches. Table 2 summarizes physiological and psychological reactions to color.

Table 2
Categories, Issues, and Findings Related to Physiological and Psychological Reactions to Color

Category	Findings	Source
Physiological Differences	Color discrimination distorted along blue-yellow system with ADHD	*Banaschewsk et al., 2006*
Physiological Reactions	Relieves eye fatigue	*Engelbrecht, 2003*
	Changes in blood pressure and brain development	
	Eyes and skin detect color rays	*Morton, 1998*
	Bright, warm colors stimulate autonomic nervous system	
	Soft, cool colors retard autonomic nervous system	
Psychological Reactions	Color can have an adverse affect on the behavior of students with ASD.	*Shabha, 2006* *Gaines, 2008*
	Monotone environments create restlessness	
	Warm, neutral colors prevent overstimulation	*Engelbrecht, 2003* *Clay, 2004*
	Blind and sighted children react to color	*Myler et al., 2003*
	Color preferences change with age	*Engelbrecht, 2003* *Terwogt & Hoeksma, 2001*
Mood	Subjects unable to screen environmental stimuli were more angry in an office painted white and depressed in the office painted red	*Morton, 1998*
Attention	Improvement with colored paper	*Imhof, 2004*
	Use of color improves attention	*Zentall & Dwyer, 1989*
	Workers in offices with saturated colors reported more vigor – blue and green highest scores	*Engelbrecht, 2003* *Morton, 1998*
	Easily distracted subjects scored lower in proofreading in a red office	
	Subjects not easily distracted scored lower in a blue office	
Productivity	Improved academic performance	*Engelbrecht, 2003*
	White and off-white environments less efficient	*Engelbrecht, 2003* *Morton, 1998*

Category	Findings	Source
Accuracy	Improved academic performance	*Engelbrecht, 2003*
	Improvement in reading with colored lenses and overlays	*O'Connor, 1990* *Imhof, 2004* *Wilkins, 1996*
	Drop in accidents with introduction of color	*Englelbrecht, 2003*

Conclusion

The present analysis is perhaps the first to investigate the appropriate use of color for inclusive classroom design. Color has the ability to impact student attention, behavior, and achievement. The proper application of color in the classroom has become more important due to the move toward inclusion in the public schools of the United States. New demands are placed on academic spaces because of increase in the prevalence of students with learning disabilities. Many students with disabilities are more sensitive to color within the classroom.

When choosing colors in educational environments, the functional aspects rather than aesthetics of color should be emphasized. Over-stimulation through color creates sensory overload. In contrast, colorless interior spaces can be stressful and nonproductive. In other words, an under-stimulating environment may be as harmful as one that is over-stimulating. In addition, empirical studies support the existence of individual and gender differences in choosing appropriate colors for learning environments. Initially, the studies appear to be in opposition to one another with regard to the proper use of color in learning environments.

However, when the empirical evidence is reviewed as a whole, it reveals that in order to facilitate learning, balance is needed in color applications for classrooms. Through the analysis of literature, six recommendations can be made for incorporating color in learning spaces. These recommendations apply to every classroom, whether or not students with disabilities are present. (1)Teachers may have little control over wall, floor, and ceiling colors in the classroom; however, a warm neutral color scheme of tan or sand would be a desirable foundation for classroom design and should be applied to those surfaces. (2) The wall that students focus on when looking up from their work should be a medium hue in the same color range. (3) Strong or primary colors should be avoided; however, soft colors such as green or blue may be used in other areas within the classroom. (4) Discovering a child's color preferences and using those colors may be beneficial. (5) Personal applications of color may be easily added through study carrels, colored reading lenses, and colored paper. (6) Using different colored tape for boundaries or to serve as a means to locate charts (e.g. a teacher might direct students to look at the green poster) will benefit students with or without disabilities.

A walk through the halls of many United States public schools will reveal that signal detection theory is being ignored. Teachers need to be aware that color within the classroom has an effect on student mood, behavior, and performance. The impact of color on students with and without disabilities warrants further investigation.

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